Smart design & technologies for a sustainable textile industry
The textile-clothing industry is reckoned to be the 3rd most polluting industry after oil and paper industries.

In fact, it is the greatest consumer of water and pesticides for cotton growing, of energy for wool or silk, of solvents and chemical substances for viscose and textile finishes and of non-renewable resources for synthetic materials derived from petro-chemicals, such as polyester, polyamide or elastane. And this impact is growing at the same frenetic pace as Fast Fashion: we now produce twice as many clothes as we did 20 years ago!

The direct consequence of this unbridled production is a large increase in textile waste: 13.1 million tons of textiles are thrown away worldwide every year.

Beyond that, the question of the safety of the materials is of particular importance to consumers, especially in the sectors of lingerie, swimwear and activewear where the body is in direct contact with the product. So consumers are asking more and more questions about the origins of materials, the chemical substances used but also about the entire manufacturing process. To sum up, they are demanding healthy and safe products with a limited environmental impact caused by production processes, and which are also easy to recycle and recover.

To meet these requirements, it is now vital to completely rethink the way we produce, and to apply eco-design principles with the aim of optimising the impact on the environment (water and energy consumption, global warming, depletion of natural resources, amount of waste generated, etc.) and on human health (human toxicity) throughout the product life cycle, while maintaining product performance and avoiding pollution transfers linked to different alternatives that may be considered.

Fortunately, many industrialists are already deploying their ingenuity to protect the planet and human beings, by creating raw materials and production processes which meet the environmental and societal challenges associated with this industry sector. And if these solutions did not have the same level of performance as conventional solutions a few years ago, this new generation of fibres and processes which is more environmentally friendly, now offers numerous functionalities which could seduce brands and meet consumer expectations.

For this very reason, Eurovet, in partnership with the Knitwear, Lingerie & Swimwear Federation, has this year chosen to highlight these “sustainable” innovations because of their relevance to the lingerie, swimwear and activewear markets across the entire production chain.

Dare to think your product! In order to help you to do just that, Reduce, Reuse and Recycle are the three principles at the heart of the Innovation forum and this leaflet!

Laurence NÉRÉE
Interfilière Paris Exhibition Manager
What is an "eco-material"? According to the collective opinion, it is a material whose main quality is to have a positive impact on the environment. Unfortunately, as soon as a raw material is extracted then transformed so that it can be exploited, it necessarily has an impact on our planet’s resources. It is therefore difficult to speak about a positive impact. For beyond depleting the raw material itself, there is also the depletion of water, crude oil and energy reserves to consider. Industrial activity will thus always have an impact on the environment.

The challenge is therefore to limit and reduce the impact of industrial activity by choosing the right materials for the right purpose. The same applies to the choice of transformation processes.

To reduce a product’s environmental impact, it is very tempting to reduce the quantity of materials used. However, when trying to reduce materials, it is essential to take into account the product’s purpose, so that the "new" product performs as well as the original one. If the product is single-use, reducing the quantity of materials can be an acceptable solution. But for a "sustainable" product, the reduction of materials must be assessed in view of the quality and life-span required for the product. Indeed, if the product is not durable enough, the consumer will have to replace it by another one. We will therefore have to compare the environmental impacts of producing two products as opposed to that of producing one product with a longer lifespan, and the results will certainly come out in favour of the latter.

So, when committing to an eco-design approach, it is essential to integrate the usual criteria that come into play when designing a product, namely the expected functionality and usage, customer expectations, cost, etc.

When it comes to lingerie, it is recommended that "resistant" materials should be used for "basic" products which will be worn and washed regularly. Inversely, more "delicate" products can be used for items that are only worn occasionally. Likewise, the fabric chosen for an "active" sports legging (running, cycling, etc.) will need to be resistant to wear, and seam assembly will need to be "solid" to avoid "tears".

Purpose and environmental impact
There are two large families of textile fibres: natural textile fibres and chemical textile fibres.

Natural textile fibres naturally occur in fibre form, be that of vegetable or animal origin. Chemical textile fibres are obtained through chemical transformation and do not occur naturally in fibre form.

Moreover, chemical textile fibres can be divided into two categories: artificial textile fibres and synthetic textile fibres. The former are obtained by chemically treating a natural, renewable material; the latter are obtained by a complex chemical reaction (called polymerisation) of non-renewable raw materials (such as petroleum).

It is therefore useful to identify and quantify the environmental impact of different textile raw materials and production processes, even if it is not easy to set up a comparative list of advantages and disadvantages for each textile fibre and process in terms of the desired properties.

To help you make these choices, you will find tables below which show the technical and environmental qualities of the most commonly used textile fibres in the fields of lingerie, swimwear and activewear but also the main processes of dyeing and printing.
**COTTON**

Cotton fibre comes from the white, fluffy capsule that surrounds the cotton plant seed. The quality of the cotton depends on the length of the fibres and on the cleanliness or “grade”. Egyptian cotton is renowned as one of the highest quality cottons, because of the fineness, strength and length of its fibres.

**PROPERTIES ADVANTAGES**
- “Cheap” price.
- Good strength.
- Soft and pleasant touch.
- Easy care (up to 95°C).
- Good capacity for moisture absorption.
- Good resistance to UV rays.

**PROPERTIES DISADVANTAGES**
- Difficult to dry.
- Poor crease recovery (creases easily).

**ENVIRONMENTAL IMPACT ADVANTAGES**
- Fibre is “appreciated” by “sensitive skins”.

**ENVIRONMENTAL IMPACT DISADVANTAGES**
- High usage of pesticides.
- Very high water consumption.
- Controversial use of GM varieties.

**LINEN**

Linen is a fibre which comes from the bast of the flax plant (“Linum usitatissimum”), contained in its stems. Bast is a long, strong, fibrous structure, which is extracted from the stem by retting and then scutching.

**PROPERTIES ADVANTAGES**
- Softness and flexibility.
- Easy care.
- Very resistant fibre.
- Easy to dye.
- Pleasant to wear and feeling of “freshness”.
- Hypoallergenic and antibacterial fibre.
- Biodegradable fibre.

**PROPERTIES DISADVANTAGES**
- Strong tendency to crease.
- Rustic appearance.
- Difficult to knit, and to use in lingerie or activewear.
- Fibre unsuitable for swimwear.

**ENVIRONMENTAL IMPACT ADVANTAGES**
- Does not require irrigation.
- Uses low amount of pesticides.
- High production density per hectare.
- European production.
- Biodegradable fibre.

**ENVIRONMENTAL IMPACT DISADVANTAGES**
- The retting stage must be carried out in the air and not in water so as to avoid high water and soil pollution.
- High carbon footprint if spinning is done in Asia when the fibre is produced in Europe.

**WOOL**

Wool is sheep hair. This hair is an insoluble protein molecule called “keratin”. The average fibre diameter and length are important factors in determining its quality. The most commonly used wool in clothing comes from the Merino sheep, a breed of sheep that is originally from Spain and is now mainly raised in Australia and New Zealand. It is particularly fine and is therefore highly appreciated by sports brands, lingerie and homewear.

**PROPERTIES ADVANTAGES**
- Good for insulation (thermal protection).
- Very good capacity for moisture absorption.
- Good crease recovery (hardly creases).
- Softness, elasticity and suppleness.
- Resistant and long-lasting fibre.
- Takes up dyes easily, and also natural ones.
- Requires less washing than other fibres.

**PROPERTIES DISADVANTAGES**
- Relatively high price.
- Poor mechanical resistance.
- Difficult care: tendency to felt and pill when rubbed.
- Fibre is sensitive to mites.
- Fibre is not suitable for swimwear (sensitive to chlorine).

**ENVIRONMENTAL IMPACT ADVANTAGES**
- Resistant and long-lasting fibre.
- Strong fibre, suitable for mechanical recycling.
- Takes up dyes easily, and also natural ones.
- Biodegradable fibre.

**ENVIRONMENTAL IMPACT DISADVANTAGES**
- Sheep breeding is “greedy” in terms of agricultural land.
- Numerous chemical products are used to treat and clean the wool after shearing.
- Risk that animals may be subjected to poor welfare.
**ARTIFICIAL textile fibres**

Viscose is a fibre obtained by modifying plant cellulose using toxic, non-reusable solvents; this is then extruded and drawn to the desired shape and length. This cellulose generally comes from wood (poplar, eucalyptus or Canadian white pine), but can also be derived from bamboo. Treatment with caustic soda gives to the viscose a very shiny or silky intensity. The main difficulty in terms of traceability comes from the manufacturing process, because the plant pulp is chemically dissolved which makes it impossible to determine its origin.

<table>
<thead>
<tr>
<th>PROPERTIES ADVANTAGES</th>
<th>PROPERTIES DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Long, smooth and shiny fibre.</td>
<td>- Relatively high price.</td>
</tr>
<tr>
<td>- Good insulating properties.</td>
<td>- Fibre sensitive to rubbing, bleach and light (discolouring).</td>
</tr>
<tr>
<td>- Resistant fibre and very good restoration capability. Soft, fluid feel.</td>
<td>- Delicate care needed.</td>
</tr>
<tr>
<td>- Good capacity for moisture absorption.</td>
<td></td>
</tr>
<tr>
<td>- Good results with natural dyes.</td>
<td></td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL IMPACT ADVANTAGES**

- Good results with natural dyes.
- Biodegradable fibre.

**ENVIRONMENTAL IMPACT DISADVANTAGES**

- Needs a lot of resources: water and ground for cultivating.
- Uses a lot of energy.
- Management of co-products.
- Problem of animal welfare.

Faced with the toxic manufacturing process of viscose fibres, industrialists developed lyocell. The wood pulp (beech, pine or spruce) is plunged into a bath containing a reusable organic solvent, which dissolves the cellulose. This is then filtered, extruded and drawn, as for viscose.

<table>
<thead>
<tr>
<th>PROPERTIES ADVANTAGES</th>
<th>PROPERTIES DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Good resistance and extensibility, both dry and wet.</td>
<td>- Sensitive to fibrillation.</td>
</tr>
<tr>
<td>- “Peach skin” feel.</td>
<td></td>
</tr>
<tr>
<td>- Suitable for use as “micro-fibres” fibres with a low diameter.</td>
<td></td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL IMPACT ADVANTAGES**

- Renewable (wood pulp).

**ENVIRONMENTAL IMPACT DISADVANTAGES**

- Impossible to trace raw materials.

It is also possible to wait until the moth comes out of the cocoon and gnaws part of it away. The fibres are then not so long and of lower quality. This is the process used for Tussah silk or “wild silk”.

**SILK**

Silk fibres are derived from the secretion of the caterpillar of the Bombyx Mori moth (Gypsy moth). Once the cocoons are finished, they are plunged into hot water, which scalds the insects; this dissolves the sericin, which is natural protein “glue”. So a continuous and very fine filament (diameter of 5 to 10 microns) is retrieved, about 1 kilometre long, called “raw silk”. Then, it is twisted again to make thicker threads for the clothing industry. In this case, the fibre remains intact, and this allows longer and therefore better quality threads to be created.

It is worth noting that 90% of world silk production comes from the breeding of Bombyx mori.

<table>
<thead>
<tr>
<th>PROPERTIES ADVANTAGES</th>
<th>PROPERTIES DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Long, smooth and shiny fibre.</td>
<td>- Not very elastic.</td>
</tr>
<tr>
<td>- Good insulating properties.</td>
<td>- Low resistance (especially when it is wet).</td>
</tr>
<tr>
<td>- Resistant fibre and very good restoration capability. Soft, fluid feel.</td>
<td>- Strong tendency to shrink.</td>
</tr>
<tr>
<td>- Good capacity for moisture absorption.</td>
<td>- Creases easily.</td>
</tr>
<tr>
<td>- Good results with natural dyes.</td>
<td>- Tends to discolor.</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL IMPACT ADVANTAGES**

- Renewable (wood pulp).
- Cellulose fibres can be recycled.

**ENVIRONMENTAL IMPACT DISADVANTAGES**

- Process uses a toxic, non-reusable solvent.
- Impossible to trace raw materials.
- High water consumption.
**SYNTHETIC textile fibres**

These synthetic fibres, which are entirely manufactured from petroleum or recycled plastics, were created to cover the world shortage of natural fibres, but also in order to have textile fibres at a moderate cost with specific properties (solidity, easy care, extensibility, etc.).

The major environmental challenge with these fibres is how to recycle them, in order to reduce dependency on the non-renewable raw materials used by the textile sector.

### POLYAMIDE

Polyamide is a synthetic fibre obtained by drawing substances (polymers), resulting from the reaction of an acid with another petroleum-derived product (adipic acid and hexamethylenediamine).

Nylon corresponds to polyamide 6.6, it is more resistant than classic polyamide. There are also other polyamide typologies, such as polyamide 11.

### MODAL

The modal process is based on viscose process but is different at the drawing and coagulation bath stages, which contain additional chemical products.

### CUPRO

The cupro process, which is similar to the viscose one, uses linters (short fibres which cling to cotton seeds) diluted in a cupro-ammonium solution. Once they have been modified in this way, they are then extruded as filament threads with the desired shape.
### Polyester

Polyester is the result of condensing (esterifying) two petroleum components: an acid (terephthalic acid) and an alcohol (ethylene glycol).

<table>
<thead>
<tr>
<th>PROPERTIES ADVANTAGES</th>
<th>PROPERTIES DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Easy care (fast washing and drying) and crease resistance.</td>
<td></td>
</tr>
<tr>
<td>- High tensile strength and low wear and tear.</td>
<td></td>
</tr>
<tr>
<td>- Very good elasticity.</td>
<td></td>
</tr>
<tr>
<td>- Good resistance to various kinds of attack (light, micro-organisms, etc.).</td>
<td></td>
</tr>
<tr>
<td>- Feels quite “rough”.</td>
<td></td>
</tr>
<tr>
<td>- Low absorption power.</td>
<td></td>
</tr>
<tr>
<td>- Non-breathing fibre.</td>
<td></td>
</tr>
<tr>
<td>- Difficult to dye; the process has to be carried out at high temperatures.</td>
<td></td>
</tr>
<tr>
<td>- Tendency to pill when mixed with other fibres.</td>
<td></td>
</tr>
<tr>
<td>- Static.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACT ADVANTAGES</th>
<th>ENVIRONMENTAL IMPACT DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Resiliency of the material.</td>
<td></td>
</tr>
<tr>
<td>- Recycled fibres are relatively easy to come by and have the same performance as virgin fibres.</td>
<td></td>
</tr>
<tr>
<td>- Non-renewable.</td>
<td></td>
</tr>
<tr>
<td>- High energy consumption.</td>
<td></td>
</tr>
<tr>
<td>- High Green House Gas emissions (GHG).</td>
<td></td>
</tr>
<tr>
<td>- Non-biodegradable (accumulates in the environment).</td>
<td></td>
</tr>
</tbody>
</table>

### Modified polyesters

Three types of modified polyesters can be used as alternatives to elastane, while still maintaining the properties that are specific to polyester.

**PTT (PolyTrimethylene Terephthalate)**

Appreciated for its suppleness, its elastic recovery and especially for its dyeability (lower dyeing temperatures than polyester), PTT marries the comfort of polyamide (soft to the touch) with polyester’s easy care (fast drying, stain resistant, etc.). Its resiliency also confers a stretch effect in the textured version, which can reduce or even remove the need for elastane.

**PBT (PolyButylene Terephthalate)**

This fibre has good resistance to bleach and to UV, and is not affected by frequent washing. Additionally, it is about three times more elastic than a standard polyester fibre and also has a better shrink back capacity. It is therefore suitable for designing swim suit and sports garments.

**Elastomultiester**

Elastomultiester is a thread composed of filaments made up of polymers with different shrinkages. This construction produces a thread that has its own elongation and shrinkage without requiring a specific treatment. This thread can be used in all types of fabric with elastic properties, bare or gimped (hidden behind another fibre in the thread).

### Elastane

This synthetic fibre is a modified polyurethane, which is made up of flexible segments maintained by rigid segments. Elastane cannot be used on its own; its feel and its very high compression capacity do not lend themselves to that. In actual fact, it is only present in clothes in very low proportions (between 2 and 5% for ready-made clothes, and up to 33% for high-compression sports leggings) and it must be mixed in with the thread or the fabric, depending on the effect sought-after.

To compensate for the disadvantages of elastane, modified polyesters are being increasingly used.
The most used colorants: affinity with the main textile fibres and environmental impact

**Finishing, and especially the textile dyeing and printing stages, is known for its particularly polluting processes.**

When developing a product, it is therefore very important to take into account the environmental impact of the chosen dyeing or printing process and to make sure that it is well-controlled.

Furthermore, as different colorants are not suitable for all fibres, the choice of fibre in the early stages is doubly determining.

Below we shall review, the two main colouring processes for a textile base:

- **Dyeing.**
- **Printing,** with **fixed-washed printing** ("localised dyeing" on a textile base and **pigment printing** (surface deposit, on a textile base, of a printing paste coloured by pigments).

### Main finishes and environmental impact

<table>
<thead>
<tr>
<th>Colorants</th>
<th>Wool</th>
<th>Silk</th>
<th>Cotton, linen, viscose, modal, lyocell, modal, cupro</th>
<th>Polyamide</th>
<th>Polyester</th>
<th>Toxicity</th>
<th>Environmental processes (water and energy)</th>
<th>Textile base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td></td>
<td>Medium</td>
<td>Poor</td>
<td>Yarn, fabric, garment</td>
</tr>
<tr>
<td>Direct</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td></td>
<td>Medium</td>
<td>Poor</td>
<td>Yarn, fabric, garment</td>
</tr>
<tr>
<td>Reactive</td>
<td>X</td>
<td>X</td>
<td>XX</td>
<td></td>
<td></td>
<td>Poor</td>
<td>Good</td>
<td>Yarn, fabric, garment</td>
</tr>
<tr>
<td>Vat</td>
<td>X</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
<td>Poor</td>
<td>Excellent</td>
<td>Dope</td>
</tr>
<tr>
<td>Dispersed</td>
<td>X</td>
<td></td>
<td>X</td>
<td>XX</td>
<td></td>
<td>Good</td>
<td>Craft scale</td>
<td>Yarn, fabric, garment</td>
</tr>
<tr>
<td>Dope</td>
<td></td>
<td></td>
<td>X (cotton &amp; linen)</td>
<td></td>
<td></td>
<td>Excellent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>XX</td>
<td>XX</td>
<td>(cotton &amp; linen)</td>
<td></td>
<td></td>
<td>Craft scale</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

XX: Frequent use - X: Limited use.

Possible concern for contamination with hazardous chemicals identified by ECHA (European Chemicals Agency) and by Greenpeace’s “Detox” campaign.

Significant risk of contamination with hazardous chemicals identified by ECHA and by Greenpeace’s “Detox” campaign.
Various printing techniques: main specifications and environmental impact

<table>
<thead>
<tr>
<th>Printing techniques</th>
<th>Quality</th>
<th>Number of colours</th>
<th>Environmental impact of printing process (water and energy)</th>
<th>Relative cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat bed screen printing</td>
<td>Good</td>
<td>96 maximum</td>
<td>Medium</td>
<td>€€€€€</td>
</tr>
<tr>
<td>Pigment rotary screen printing</td>
<td>Good</td>
<td>14</td>
<td>Medium</td>
<td>€</td>
</tr>
<tr>
<td>Reactive rotary screen printing</td>
<td>Good</td>
<td>14</td>
<td>Poor (needs to be washed)</td>
<td>€€</td>
</tr>
<tr>
<td>Pigment digital printing</td>
<td>Very good (high resolution)</td>
<td>Infinite number of colours but no white</td>
<td>Excellent</td>
<td>€€</td>
</tr>
<tr>
<td>Reactive digital printing</td>
<td>Very good (pass-through depends on print speed)</td>
<td>Infinite number of colours but no white</td>
<td>Very good (needs to be washed)</td>
<td>€€€€</td>
</tr>
<tr>
<td>Inkjet transfer printing</td>
<td>Good (polyester)</td>
<td>Infinite number of colours but no white</td>
<td>Good</td>
<td>€€</td>
</tr>
</tbody>
</table>

Pollutant loads in water can mainly be put down to reactive printing processes. In fact, in pigment printing, the pigments are completely fixed on the fibre, and no washing is necessary. Drying and fixing, which are crucial steps in pigment printing, constitute another major source of toxic emissions. This pollution comes from the colorants which have not been fixed to the fibre but also from the chemical compounds in the printing paste emulsions, like thickeners, binders, etc.

Life Cycle Analysis, an indispensable tool for eco-design

Once the environmental impacts of textile fibre production and dyeing and printing processes have been examined, environmental impacts throughout the whole product life cycle must be analysed in order to have an eco-designed product. This includes all stages of transformation, distribution, utilisation, care, and end of life.

The notion of Life Cycle Analysis (LCA) of a product is of capital importance. LCA quantifies incoming/outgoing fluxes of materials and energy (raw materials, energy, water, chemicals, etc.) at each stage of the life cycle of a product. Using this data, overall environmental impact is evaluated: water and energy consumption, global warming, depletion of natural resources, acidification, eutrophication, aquatic and human toxicity, amount of non-recoverable generated waste, etc. The major focus of LCA is to identify the main sources of environmental impact in order to avoid them or, as appropriate, to arbitrate pollution transfers linked to the different alternatives under consideration. It is therefore a useful decision-making tool for industrial policies (design choices, processes, product improvement, etc.) or public policies (choice of development pathways, criteria for eco-labelling products, etc.).

LCA is the basis for eco-design, a process which aims to include environmental impact in product design, as well as the usual criteria that come into play (clients expectations, costs, functionalities, etc.). LCA allows establishing a list of the priority actions to be led.

An eco-designed product is thus a product which optimises the impact on the environment and on human health for the entire length of its life cycle, while preserving its performance when used.
LIFE CYCLE OF A SWIMSUIT

DEPENDENCE ON NON-RENEWABLE RESOURCES

Man-made cellulose fibres:
- Lenzing™ EcoVero fibre, developed by Lenzing, and manufactured from wood pulp from certified forests FSC® or PEFC®.
- Monocel® fibre, developed by Monocel AS, and manufactured with the lyocell process from bamboo cellulose, grown from 4 to 6 years before being hand-picked.

Biosynthetic fibres:
- Polyamide fibres manufactured from castor oil: Rislan® fibre by Arkema and Evo® fibre by Fulgar.
- Umorfil® fibre which uses compounds of fish skins: this technology can be used with viscose, polyamide and polyester fibres. Collagen from the fish skin is added to the fibre and gives it moisturising properties.

Protein fibres developed from different types of agro-food industry waste:
- From milk casein: QMilk fibre by Qmilch GmbH.
- From citrus peel cellulose: Orange Fiber by Orange Fiber S.r.l.
- From organic waste (food industry): Nanollose fibre by Nanollose Ltd.
- From artificial silk (spider silk): Spiber® fibre by Spiber Technologies AB or BioSteel® fibre by AMSilk which can replace certain high-resistance fibres like Cordura® by Invista and Dyneema® by DSM.

Rethinking elastane usage:
- Use latex or rubber instead of petroleum for polymerisation: Lycra® fibre by Invista.
- Use modified polyester, such as biosourced PTT based on corn starch: Sorona® fibre by DuPont.

IMPACT OF MANUFACTURING PROCESSES

Assembly:
- Lectra uses thermal welding by bicomponent fibres, thus avoiding the use of auxiliary substances for welding.

Dyeing:
- The start-up Pili is developing environmentally friendly colorants produced by micro-organisms.
- Dyecoo has developed a technology that uses supercritical CO₂ as a solvent to dissolve the colorant. This process does not use water, is short (2 hours) – which limits energy usage – and any unused colorant can be recycled.
- Archroma has developed a new range of environmentally friendly colorants that are fully traceable, called EarthColors®, which are synthesized from non-consumable agro-food industry waste (walnut shells, almond hulls, etc.), and are certified by Bluesign and GOTS.
- Borgolon has perfected Micronol, a mass dyeing process (the colorant is mixed with the synthetic fibre before extrusion) which therefore does not consume any water. This process can only be used with synthetic fibres.

Washing:
- Penn Textile Solutions has developed the EcoWash process which reduces the use of surfactants, water and energy during dyeing processes, and the use of chemical products and water for machine maintenance.

Relocalisation:
- Use of French materials: Velcorex uses nettles.
- European production of certified linen fibre: European Flax®.
- Linen transformation 100% "Made in Europe", from the plant to the yarn and the fabric: Master of Linen® label.

WATER AND PESTICIDE CONSUMPTION BY CHOOSING ALTERNATIVES TO CONVENTIONAL COTTON AND VISCOSE

Cotton from organic agriculture uses less water and is not treated with any pesticides during growth. BCI (Better Cotton Initiative) certified cotton guarantees that less water is used during growth. Linen is a plant which does not require irrigation and use of pesticides is extremely limited.

PACKAGING

Braiform is a hanger-rent solution for points of sale. Cadicagroup has developed "responsible" labels.

CARE

Functionalisé fibres to make them anti-bacterial and reduce washing frequency (Umorfil®, SolucellAla™, etc.).

HARMFULNESS OF TEXTILE WASTE

Biodegradable synthetic fibres (Amni Soul Eco® by Solvay and Fulgar, Roica® Ecosmart by Asahi Kasei, etc.). Recreate textiles from the outgassing that comes from the decomposition of textiles (Mango Materials®).
RECYCLE

SYNTHETIC MATERIALS
Recycled polyester from PET bottles (Ecopet™ by Teijin, Repreve® by Unifi) or from plastic waste from the sea (Seaqual™ by Sequal 4U). Polyamide from recycled fishing nets (Econyl™ by Aquafil). Recycling of material losses during fibre manufacturing (Roica™ Eco Smart by Asahi Kasei).

MAN-MADE MATERIALS
Lyocell recycled with Refibra™ by Lenzing or Cupro™ by Asahi Kasei.

NATURAL MATERIALS
Mechanically recycled cashmere Re.Verso™ by industrialists in the Prato region, in Italy.

TEXTILE WASTE
More Color Green and Eco Heather by Teairfi. Armor Lux and Cornilleau have designed a ping-pong racket called “Softbat” made up of 60% recycled fabrics or textile scraps from the Armor Lux group.

REUSE

FABRIC OFFCUTS
Indigo cotton by Industrias Moreira.

PRODUCTS
Improve the life-span of garments by using longer fibres (better quality wool, cotton: Supima®, Sewpure™ by Fiberactive organics), or more resistant fibres (Cordura® by Invista, etc.).

SECOND HAND
Petit Bateau and Cyrillus have opened up online sites for the resale of their products for and by consumers.

UPCYCLING D’INVENDUS
Viktor & Rolf x Zalando have reworked their end of stock lines to make these products desirable again.

COMMITMENT

Guaranteeing efforts made

If these initiatives are not quantified by manufacturers and identified by end consumers, the efforts made by the sector cannot be appreciated and recognised for their contribution to reducing the industry’s global impact.

In order to make these commitments visible, tangible and credible for industry players and consumers, stringent but realistic environmental criteria must be followed and these should be verifiable throughout the entire length of the supply chain. These criteria are generally grouped together in the standards, labels/certifications and charters put forward in collective initiatives. As for the traceability, namely the linkages between the beginning and the end of the supply chain and concomitant respect for these criteria, it is guaranteed through technical solutions.

SUPPLIERS GUARANTEES
This is currently the system most in use. It entails “attaching” the guarantees supplied higher up the supply chain to each and every product. This is a very heavy and expensive system, because of the technical means and administration required. Other technologies are therefore under test with a view to replacing it.

MARKED FIBRES
This technique, which only applies to chemical fibres, involves the inclusion of recognisable elements or the specific conformation of the fibre when it is extruded. By doing this, we will be able to recognise the finished product that contains these “marked” fibres by simple chemical analysis or by observation under the microscope. This process is used in particular by the company Seaqual 4U.

About SEAQUAL™
Sequal 4U was founded in 2016 with the aim of setting up a virtuous economic model to tackle marine pollution, starting with the upcycling of plastic marine waste into continuous and discontinuous yarns. To achieve this, the SEAQUAL™-brand fibre has acted as a catalyst for clean-up initiatives, getting the entire textile industry on board and inspiring consumers.
RFID
This new technology enables radio frequency identification. Developed by the company Primo1D, this technology allows a micro-chip containing information to be integrated into the textile threads from the beginning of the design process. The micro-chip then carries with it an invisible, lasting and washable "trace".

CHEMICAL "DIGITAL" FINGERPRINT
By meticulously analysing different cotton varieties, Welspun group’s Oritain project has established a unique database of "chemical digital fingerprints" for quality cottons like Egyptian cotton, Supima® cotton and the cotton of the Australian highlands, but also for New Zealand wool. The fingerprint of a sample can thus be compared to its theoretical fingerprint in order to guarantee its origin at every stage of production, in order to guarantee the authenticity of the finished product. This database will soon also include the characteristics of organic cotton.

BLOCKCHAIN
Blockchain, or "chain of blocks", is a technology for storing and transmitting information without oversight bodies. By extension, a blockchain is a distributed database, in perpetual expansion, which manages a list of records that are protected against falsification or modification by storage nodes (security). A blockchain is therefore a secure, distributed ledger of all transactions that have been carried out since the beginning of the distributed system. Data are recorded and secured in block structures, where all the blocks keep a trace of individual transactions. This means that the database is secure, open and auditable and that it works without a single, centralised operator. This technology helps to reduce costs and eliminates the need for oversight bodies.

If used in the textile-clothing industry, such transparent, secured databases would contain a history of all the exchanges and transactions that have taken place among stakeholders from design right down to distribution of a product to shops. This would guarantee "absolute" and total traceability. Consumers could consult this information.

Bext360, a company which has already used this technology for the traceability of coffee, has just joined the "Fashion for Good" programme with the aim of improving the global industry using digital solutions (Blockchain, Artificial Intelligence, etc.). These would validate claims about product provenance, product authenticity and the conditions under which products are being made.

STANDARDS
A standard refers to a group of specifications which together describe an object or a way of operating. This results in a principle which serves as a rule and a technical reference. A standard is not mandatory but voluntary; some standards can be made mandatory by a regulatory text. They are drawn up by the ISO (International Standardisation Organisation) at an international level, by the CEN (European Standardisation Committee) at a European level, and by AFNOR (French Standardisation Association) at a French level and more specifically by the BNITH (Office for the Standardisation of Textiles and Clothing) for the Textile-Clothing Industry.

One relevant standard that could be mentioned is ISO 26000, pertaining to Corporate Social Responsibility, which defines how any Organisation (Business or any other Organism) can and must contribute to Sustainable Development. It has inspired many businesses in defining their CSR criteria.

LABELS / CERTIFICATIONS
A label is a certification awarded by a third party for a measure taken by an organism (business or other) on a specific theme, relating to technical specifications. It is measured by recurrent evaluations, either on site or otherwise. It comes in the form of distinctive signs (name, logo, etc.) and can be used by the different organisms that conform to the label’s specification. It is a way of informing the public about the characteristics and properties of a given product. To work effectively, a label depends on the one hand on the choice of requirements fixed in the specification and on the other hand on the independence and rigour of the authority that verifies if the criteria are met.

COLLECTIVE INITIATIVES
Some issues exceed the human and financial resources which businesses have at their disposal, be that in terms of the decisions that need to be taken or the reassurance objectives that have to be achieved. For this reason, businesses in the same sector are getting together either amongst themselves or through NGO initiatives, in order to face the challenge. They can then pool their knowledge and financial resources to offer solutions which are similar to labels or certifications.
### Ariane’s thread inside the labyrinth of textile labels

<table>
<thead>
<tr>
<th>Labels</th>
<th>Initiative</th>
<th>About</th>
<th>Toxicity</th>
<th>Environment</th>
<th>Animal welfare</th>
<th>Circular economy</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oeko-TEX® 100</td>
<td>Certification</td>
<td>All textile and clothing products</td>
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<td>ZDHC (Zero Discharge of Hazardous Chemicals)</td>
<td>Collective programme</td>
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<td>Detox</td>
<td>NGO programme</td>
<td>All textile and clothing products</td>
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<tr>
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<td>BCI (Better Cotton Initiative)</td>
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<tr>
<td>RWS (Responsible Wool Standard)</td>
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<tr>
<td>PEFC (Pan European Forest Certification)</td>
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<td>Industrial collective initiative</td>
<td>Recycled wool</td>
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<tr>
<td>Re:Verso®</td>
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<td>Recycled cashmere</td>
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<tr>
<td>ICS (Initiative Clause Sociale)</td>
<td>Sector-specific initiative</td>
<td>Global textile supply chain</td>
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<tr>
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</tbody>
</table>

- 🟢 Covers some criteria relating to the theme.
- 🟢🟢 Covers numerous criteria relating to the theme.