

White Paper

Fabric Toxicity & Sustainability

Choices that Must be Made by the Designer and the Public

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"The hidden use of toxic chemicals in clothing means that consumers are often unwittingly exposing themselves to hazardous chemicals that could have serious future consequences for their health and the environment. Children are usually more vulnerable to the effects of chemicals than adults, so the presence of these substances in school clothing is particularly alarming."

-- [Morgan Parry, Head of WWF Cymru \(UK's Welsh office\)](#)

Part 1: Understanding the Challenge

As the “eco” and “sustainability” movement gathers steam, industry players are lining up to flash their credentials as responsible actors in the theater. This is, however, a monumental challenge and cannot be surmounted by superficial actions and claims. The role of chemicals – and their toxicity – needs to be fully understood in order for the eco movement to really have a meaningful impact.

While the general public is gradually becoming aware of the health hazards of chemicals in foods, such awareness has not yet adequately percolated into public awareness about the role of chemicals in clothing and other lifestyle choices we make. That would have to change – for the designer to meet the popular demand, and for the public to know what it is demanding.

A [recent book](#) by Donna Jackson Nakazawa points out that almost 10% of the US population now suffers from autoimmune diseases, an astonishing rise from four decades ago. In an [op-ed for the Washington Post](#) and an [interview with Alternet](#), Nakazawa clearly points to the most likely culprit: *“The scientists I interviewed tended to discard the idea that [the hygiene hypothesis] alone is responsible. They agreed almost to a person that our day-to-day exposure to environmental toxins – through the air we breathe and the chemicals we absorb through our skin – is a major trigger of autoimmune disease.”*

A [WWF-Scotland study](#) conducted in 2004 illustrated the amount of chemicals an average person absorbs in industrialized societies. Alarming as they may be, the dramatic findings of this study should really come as no surprise.

In order to make informed decisions about how to minimize the risks of toxic chemicals in our clothing and in order to determine whether to use synthetic or natural fabrics, we need to get a reasonable understanding of the processes involved in the production of these products.

However complex the subject may be, the responsibility to understand it for our own benefit is now upon us all – apparel users in general and fashion designers in particular.

Present-day industrial textile production involves various steps such as carding, retting, scouring, bleaching, spinning, weaving, mercerizing, dyeing, printing, and finishing. These steps use chemicals and water – in staggering quantities. (The production of the fabric covering the sofa in your living room, for example, required between 5 and 20 pounds of chemicals!) The types of chemical agents needed include defoamers, detergents, dyes, bleach, optical brighteners, etc.

What are the chemicals under consideration here? An eye-opening list of known toxins and carcinogens: sulphuric acid, dioxin-producing bleach, formaldehyde, azobenzenes, perfluorinated chemicals (PFCs), Perfluorooctanoic acid (PFOA), volatile organic compounds (VOCs) ... the list goes on.

Finishing is the last step in textile manufacturing; and this step, in many ways, holds the key to many chemical sensitivity problems. Finishing processes enhance “performance” characteristics of fabric: shrink control, wrinkle resistance, extended life, fabric softening, and stain repellence – yes, your clothing may have been treated with Scotchguard™ and Teflon™. The finish process uses heat, which locks the molecules of toxic chemicals into the fabric; these molecules generally cannot be washed out of the fabric.

In some ways, therefore, we have to decide how important these “performance” characteristics are to us. Is avoiding wrinkles in our clothing really so important that we would like our clothing to be coated with Teflon™? And do we really want to absolutely shrink-proof our clothes even if that entails making formaldehyde a part of the fabric? Sure, we can get dirt-cheap polyester to look and feel like silk, but at what cost to our health and environment?

These are personal decisions, and it is OK for different people to approach their choices from different viewpoints. But we do need sufficient information in order to make informed decisions on a complex subject such as this.

Part 2: Production of Various Fabrics

Petrochemical-made fabrics, by definition, are heavily chemical dependent, and cannot compete with natural fibers in terms of their health effects. Besides, natural fabrics have various other functional advantages (temperature regulation and breathability to name a few) over their synthetic counterparts (to the point that, except for cheap price, synthetics cannot compete with natural fabrics in the benefits they offer).

But the conclusion that the production or use of natural fabrics is relatively better for environmental or human health would be unjustified without further understanding of how they are made.

Let's discuss the various commonly used natural fabrics and the health risks introduced in their production.

Cotton

A wonderfully versatile fabric, and man's friend for thousands of years, today's conventionally-grown cotton is arguably the most polluting and toxic crop in production, and epitomizes the worst effects of chemically dependent agriculture.

Cotton accounts for a gargantuan proportion of the world's use of pesticides, insecticides, fungicides, and toxic fertilizers. As pointed out by [Will Allen of the Organic Consumers Association](#), even though cotton is farmed on merely 3% of the world's farmland, it uses more than 25% of all the insecticides in the world and 12% of all the pesticides. US cotton growers use 25% of all the pesticides used in the country.

The "fabric of our lives™," grown according to the current industrial methods, is rather hazardous to our lives.

Linen Fabric

Made from the flax plant, linen has also been around for thousands of years. Linen is much stronger than cotton, is highly absorbent and conducts heat well. And the available information indicates that the manufacturing practices for this fabric are still true to the traditional, low-chemical retting process. What else could we ask for?

Wool

Wool, with its natural fire-retardant properties, resists flame without heavy chemical treatment needed to fireproof synthetic fleece, which, in its nature, is a highly combustible substance. Wool is also mostly non-allergenic (a small percentage of people are allergic to lanolin, the oil found in wool); thus, most allergies associated with wool are due to the chemicals going into the treatment and finishing of wool products.

Wool's other natural qualities include temperature regulation, insulation, absorbency, and mold/mildew resistance.

Today's industrial rearing of sheep, however, necessitates the use of harmful organophosphates to treat the pests, mites, and lice in a sheep's coat; not to mention the abundant use of other drugs to control the internal animal parasites as well as the antibiotics that virtually all industrially raised animals are fed.

Then comes the industrial manufacturing process, which routinely uses harsh scouring agents and bleaches to clean and whiten the wool, dioxins, moth-proofing agents, formaldehyde, and other toxic chemicals used to finish the fabric and garments. Chemical dyes frequently include toxic heavy metals such as chrome, copper, and zinc, and may contain known or suspected carcinogens.

Like cotton, the industrial production of wool is therefore highly dependent upon dangerous chemicals.

Silk

Similar to wool, silk is an animal protein fiber. With a fascinating history, abundant fabric qualities such as temperature regulation and absorbency – and peerless luxury in feel and look

– silk is arguably the queen of all fabrics. And, fortunately, its production process is fairly similar to the traditional process of yesteryear (except the industrial-age treatment of the silk moth and the worker involved in the production). With the exception of the industrial dyeing process of silk, in which chemicals such as azobenzenes and formaldehyde products are involved, silk's production tends to be relatively benign in chemical terms.

Bamboo Fabric

Bamboo fabric has recently received a lot of publicity as a “green” fabric. The demand for the fabric in North America seems to have gone up considerably, and even some [relatively known designers](#) have been promoting the benefits of this new discovery.

Is bamboo fabric really that good? Yes, if manufactured in a responsible fashion.

A grass, not a tree, bamboo is a naturally organic plant. It is a wonderfully sustainable resource. When made with natural retting process, like linen from flax, bamboo fabric is truly sustainable as well as healthy. In fact, bamboo fabric made with the natural retting process is sometimes even called bamboo linen. That, unfortunately, is not how much of bamboo fabric is made. While the retting method to process bamboo into a natural fabric (just like linen from flax) is very much available, it is more labor intensive and thus more costly. And that would not suit the current industrial paradigm of our clothing needs.

Most bamboo fabric in today's eco-fashion is regenerated cellulose fiber just like rayon whose manufacturing involves chemical solvents such as sodium hydroxide and carbon disulfide in a process called hydrolysis alkalization combined with multi-phase bleaching. Both sodium hydroxide and carbon disulfide have been linked to serious health problems. [There is evidence of carbon disulfide causing neural disorders in workers at rayon factories who have not been adequately protected.] Because of the similarities in the manufacturing process as well as in the feel and hand of the two fabrics, such chemically manufactured bamboo is also known as bamboo rayon.

While “bamboo linen” is a completely natural fabric, “bamboo rayon” can more accurately be classified as bio-based artificial fiber. However, it *is* possible to produce bamboo rayon in a socially responsible and environmentally friendly way by manufacturing the bamboo rayon with a closed loop process, in which chemicals are recycled (and not released into the environment), and when steps are taken to protect workers from exposure to harmful chemicals.

Part 3: Making Informed Choices

Ultimately, what we wear and what we don't are decisions driven by profits and economics – often of someone other than the ultimate user of the garment.

The interesting part of this paradigm, however, is that, in absolute terms – with the exception of fabrics such as silk and cashmere – the cost share of the fabric in the retail price paid by the garment user is almost negligible.

Let's run some numbers.

For comparison of cost, let's use polyester, the most common synthetic fiber, as the base reference, and the wholesale cost of other fabrics is shown in multiples of the polyester's wholesale cost. Here's how it looks:

Polyester:	1
Cotton (Conventional):	1.5
Bamboo Rayon (Cellulose) Fabric:	2
Cotton (Organic):	2.5 (FYI: even organic cotton is a highly thirsty crop)
Linen:	6
Silk:	15

For example, the wholesale cost of polyester fabric used to make a shirt is well within a dollar. The wholesale cost of organic cotton fabric for that shirt would thus be much less than \$2.5, that of linen well within \$6, and that of silk less than \$15.

In effect, and this is important to keep in mind, a cotton or polyester garment retailing at \$100 may only use fabric with a wholesale cost literally in pennies.

The retail prices really are driven by the margins of the whole distribution network, and have little to do with the cost of the fabric. Since every player in the process is strictly calculating his/her margin or markup using percentages of his/her cost, the ultimate retail price goes through a multiplier effect that grossly distorts the real difference in the prices of these fabrics.

We don't claim to know of a better way to conduct commerce. The point simply is that the retail price differential in clothing using these fabrics is not closely tied to the wholesale costs of the fabrics.

Author's Recommendation

If **dyed** and **finished** in an environmentally responsible fashion, the following would almost always be much healthier and safer than synthetic fabrics – for human health as well as the well being of the planet and its other inhabitants:

- Linen (from Flax, produced using traditional retting methods)
- Silk
- Bamboo Linen or Viscose (produced using responsible methods)
- Organic Cotton
- Organic Wool

The purpose of this writing is to bring to light some salient factors – from both personal and environmental health viewpoints – that retail buyers in general, and clothing designers in particular, should keep in mind in choosing the clothing they use or design. The author hopes that the basic information provided here would pique the interest of those who find this subject relevant to their lifestyle. Of course, such individuals would have to search for more information in order to find desirable solutions. But then, in the present day and age, who said reaching nirvana was easy!