



Clean and Innovative Textiles Strategy for Circular Economy

MODULE 7

Business and Quality Management

Unit 7.2

Features of Design for Longevity



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Introduction and Challenges

The textile industry is said to be the second most polluting industry in the world. Thus, 3 to 10% of global CO₂ emissions are caused by the textile sector, 20% of industrial water pollution is due to textile and dyeing processes, and 20 to 35% of primary microplastics come from the textile sector, making it the leading contributor to these emissions.

For a while, there is a growth in textile demand and textile production. Fashion brands are producing almost twice as much as they did 20 years ago, while in the meantime, textiles lifetime is reduced and clothes are kept less time than before. Consumers are renewing their wardrobe frequently, but more than 50% of their clothes will simply not be worn. In Europe, 4 million tons of textiles are discarded each year, mostly to be buried or incinerated.

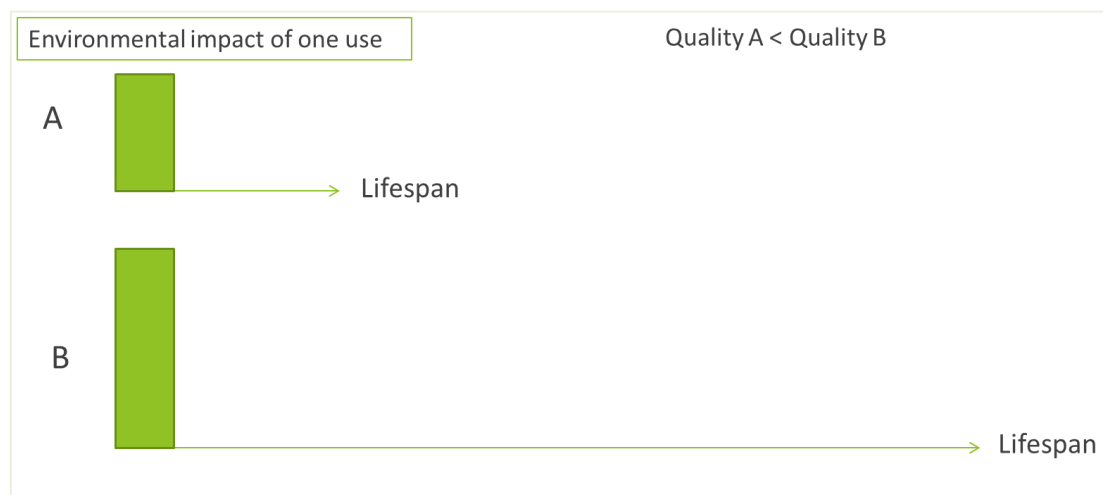
Asking and wondering about the lifespan of textiles is thus important. Indeed, studies conducted by WRAP and GEMTEX (a French textile-dedicated research laboratory) highlighted that prolonging the life period allow sustainability to be increased in the textile industry. Thus, predicting and understanding the factors that play a role in the disposal decision can help increase product lifespan and adjust its quality to the intended use [1]–[4].

A research conducted by WRAP [5] in the UK has shown that textile end-of-life accounts for 64% of produced waste. Indeed, after the 2 years of average use, most of the end-of-life clothing is landfilled. Only 14% is recycled and 14% is re-used inside the UK. However, increasing the active life of clothing by nine months would reduce the annual carbon, water and waste footprints of clothing by 20-30% each.

According to this study, the five core opportunities to save money and resources across the clothing lifecycle are:

- Reduce the resource impacts of clothing sold to the consumer
- Extend the useful life of clothing
- Increase supply and demand for pre-owned clothing
- Reduce the environmental impacts of laundry
- Keep clothes out of landfill [5]

To understand how an increased lifespan can influence the environmental evaluation, let's consider two products: product A and product B (Figure 1, Figure 2). The manufacturing environmental impact of product A is lower than that of product B. If we consider a single use, then product A looks better than product B. However, the quality of product A is lower than that of product B. Let's assume that these products are kept for longer than a single use. Due to its higher quality, product B is kept for 12 uses, while product A is kept for only 3 uses. The impact related to one usage will then be lower for product B. The conclusion to be drawn from this example is the more a product is used the more the environmental impact related to one usage will decrease. From an environmental point of view, it is better to use longer a product even if its manufacture has a higher impact. This is call Eco-design.



CoFigure 1 Example of how lifespan can influence environmental evaluation

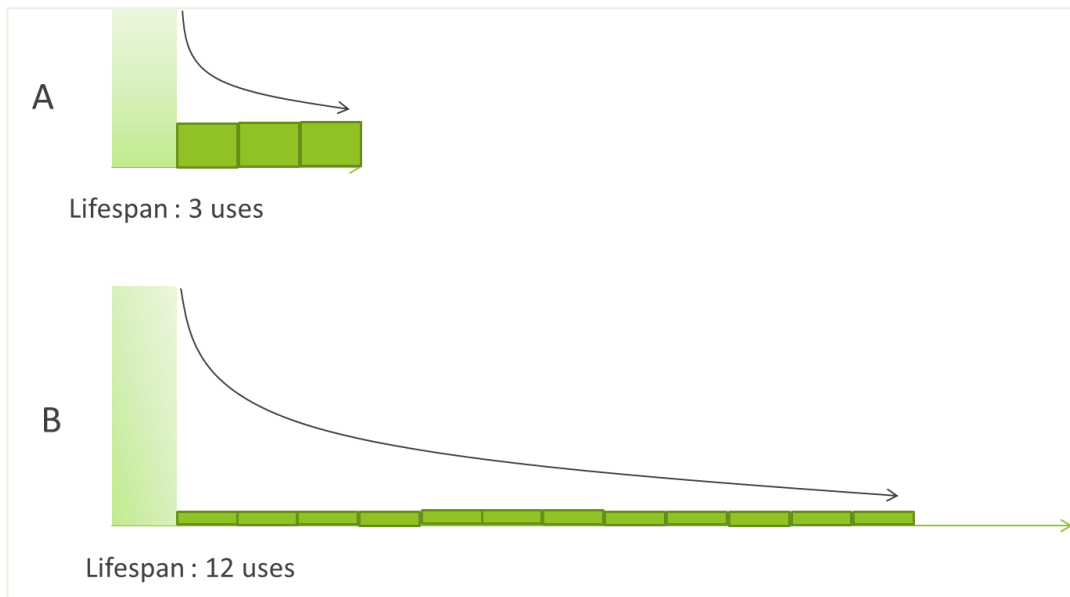


Figure 2 Example of how lifespan can influence environmental evaluation

Some definitions

As explained in section 1, design for longevity is recognized as an Ecodesign lever and extending it could have positive environmental impacts. However, what does the lifespan of a textile mean? When does it start? When is it considered to be over?

The definition that we will give to the lifespan, to the durability of a textile is going to allow us to understand what are the factors that influence it. Durability, or longevity, refers to the service life of a product and lifespan generally translates durability over time. Lifespan corresponds to the ability of a product to perform a function under given conditions of use and maintenance until a limit state is reached. Lifespan of textile articles is multifactorial as it depends on both the product and the consumer, and the reasons for disposal are various [4], [6].

To understand what parameters influence the lifespan, it's necessary to specify which lifespan we are talking about. We can differentiate the service lifespan, which is the period during which the products are technically usable, and the possession lifespan, which is the period during which the consumer uses the product.

With the notion of lifespan come the different notions of obsolescence (Figure 3) [3]. There is firstly the absolute obsolescence, which is product-oriented as it is related to the product's technical failure. This corresponds to a state in which the product can no longer perform its function. Absolute obsolescence causes the end of the product's service lifespan. There is secondly the relative obsolescence, which is consumer-oriented as it is related to the product's premature end-of-life. The relative obsolescence can be linked, among others, to a psychological, situational, functional or sentimental factor. Relative obsolescence causes the end of the product's possession lifespan. The same product can be used by several consumers, and thus have several possession lifespans. During the life of the product, the service is therefore provided to several users.

The objective of design for longevity is to produce items to last as long as possible. It corresponds to quality with regard to the weak points of the product, which are the points to which the consumer is sensitive. There are many weak points that influence the end-of-life of a product. The entire textile chain is involved, from producer (ability of the production line to produce with a constant quality e.g.) to consumer (evolution of consumer needs e.g.) [4]. Because of the number of actors, lifespan is multifactorial. We propose to focus on the consumer and the disposal causes.

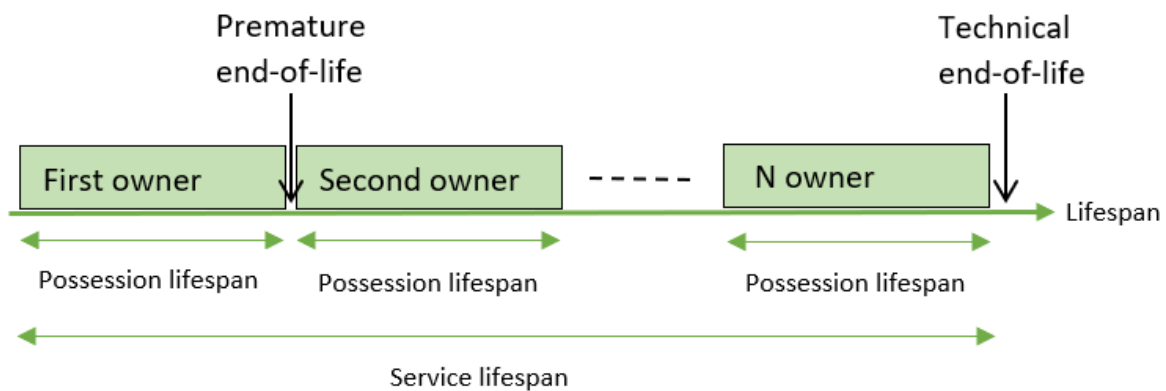


Figure 3 Notions of lifespan and obsolescence

Evaluate lifespan

As exposed just before, physical and emotional factors can lead to a product end-of-life (end of service lifespan or end of possession lifespan). The emotional causes are subjective, related to the consumer preferences (colors that are no longer in fashion, shape that no longer appeals...). Physical causes are objective as they are related to the product. Among the physical causes they are the apparition of holes, the broken seams, the pilling ... It is not possible to quantify the subjective causes of discarding, since they vary from consumer to consumer. However, the physical causes can be quantified and acted upon.

When evaluating lifespan, it is also necessary to look at the relative importance of each degradation in the disposal decision. Indeed, not all defects are perceived in the same way by the consumer. The defects that lead to discarding are different depending on the type of garments. For example, major defects on denim are break down at stress points and component failure. For knitwear, major defects are distortion, shrinkage and loss of shape. A study conducted in France, in GEMTEX also showed that on a T-shirt, the apparition of holes and deformation are the two most important causes of disposal followed by the broken seams, the degradation of color and then the apparition of pilling [4]. The perception of defects also depends on who is looking (man, woman, adult or child). For children, the major issue is the size, while for adults it's a change of taste. Women are also more sensitive to problems of size and fit than men.

Measuring lifespan

To estimate physical product longevity, we need to consider technical performances such as resistance to color change or to holes. To do so performance tests are realized.

The tests to be performed depend greatly on the final use of the product. The notions of function and service provided are then essential, as expectations are not the same for a T-shirt worn daily and a suit jacket worn occasionally for example [7]. The textile industry has a large number of standards that allow the evaluation of textiles at all scales, from fibers to finished product and in relation to all types of constraints. Some of them concern resistance to manufacturing constraints like color fastness calendaring while others are oriented to the constraints of use like color fastness to washing.

The main tests performed are:

- Color fastness (to water, to daylight, to sweat...)
- Resistance to deformation
- Seam strength
- Resistance to holes
- Pilling resistance

Test results are very heterogeneous (sometimes a high score means a good performance, sometimes not), and are independent one from the others.

Potential solutions

It is thus possible to act on the physical resistance of items. Increasing the physical performance of textiles will help increase their service lifespan. But we saw earlier that the physical performance of clothes is not the only cause of disposal. Emotional causes are also at play.

All actors in the textile industry have a role to play in increasing the life span of textiles.

This starts from the creation of the product. Some designs and styles are more likely than others to be kept for a long time. In a study conducted by WRAP [7], it was identified that the most important point to prolong the life of a garment is its cut. Designing clothes with a classic style (black dress, tailored shirts, pencil skirt, chino-style trouser), tailored or semi-tailored cut, oversized shape and classic colors (black, white, navy, grey, red...) can allow the consumer to keep their clothes longer. In the same idea, as human bodies are not all identical and change over time, designing clothes with a growth allowance or which allow size and shape adjustment (adjustable waistbands, generous seams, additional buttons...) can be a solution. Some other points have also been identified as solutions that can be implemented to help extend the life of textiles. The first one is designing multi-functional clothes (reversible clothes, or with parts that can be worn separately). Companies can also ensure care and laundry advice is clear and simple, and provide guidance for use, repair, re-use. It is also possible to design clothes with detachable parts which can be replaced when they become soiled or worn. Lastly, creating emotional attachment through ethical sourcing and production, no waste, craft design approaches or through the use of wearable technology or personalization can help increase lifespan of clothes.

Once the design is set, the choice of materials, dyes, accessories will also play an important role in the lifespan of the items [8]. Some fibers are more resistant than others, some are more breathable or warmer. The choice of fiber or fiber blends must be adapted to the final application of the garment. In the same idea, the structure of the textile must be adapted. For example, plain and twill weaves are considered the most durable options and are often used for garments that need to be durable.

Manufacturers must be careful with the dyes used, so that they are adapted to the fibers and do not fade too quickly. For example, basic dyes are well adapted to acrylic fibers, wool and silk, but cannot be used with cotton or polyester. The quality of the seams and the respect of the sizes is also important so that the customers can use the clothes as long as possible.

The consumer also has a role to play, since he has to take care of his clothes. By following the washing instructions on the labels, it is possible to prevent clothes from fading, pilling or wrinkling too quickly.

To conclude, we have seen previously that defects are perceived differently depending on the type of product. A study conducted by WRAP [7] proposed a list of solutions according to the type of article, for the entire textile manufacturing chain, and which play on both the physical and emotional causes of discarding. For example, for children's clothing, it is appropriate to create products that adapt to size change, and for knitwear it is better to use loose shapes (Figure 4).

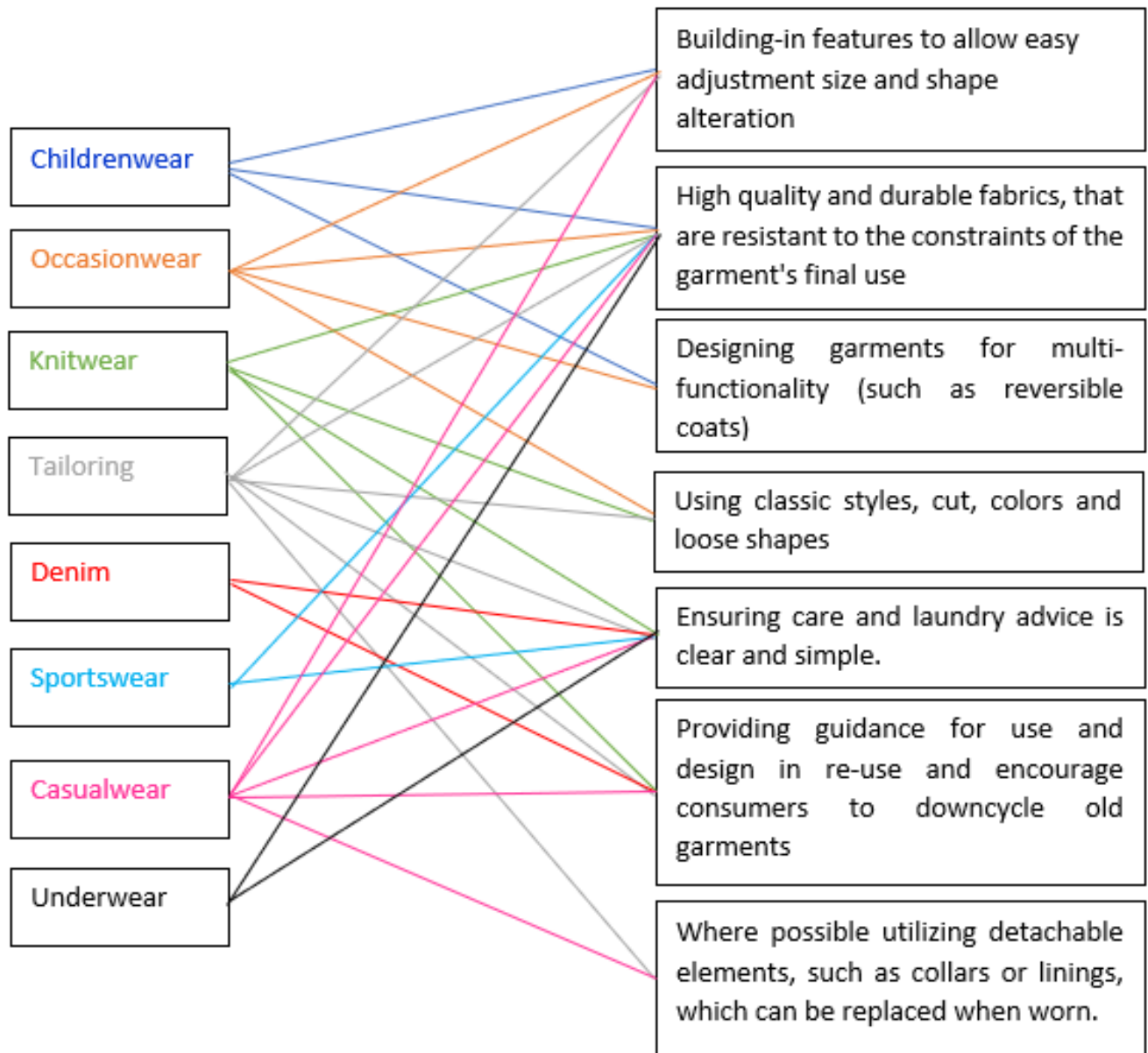


Figure 4 Solutions to extend the lifespan according to the type of clothing[7].

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