



УДК 687.016

## INTEGRATING REVERSIBLE DESIGN INTO THE CIRCULAR ECONOMY: A PATH TOWARD GARMENT LONGEVITY

SCRIPCENCO Angela

Technical University of Moldova, Chisinau, Republic of Moldova

[angela.scripcenco@dtm.utm.md](mailto:angela.scripcenco@dtm.utm.md)

*This paper analyses the role of reversible garments as a fundamental eco-design strategy within the transition to a circular economy. In an industry dominated by linear consumption, the concept of Design for Longevity (DfL) emerges as an important solution for reducing environmental impact. The article explores the dual nature of this concept, addressing both physical longevity—supported by advanced assembly techniques and high-precision finishes—and emotional longevity, derived from the aesthetic versatility of “2-in-1” products. The theoretical analysis demonstrates that, although the manufacture of these items involves higher initial resource consumption and greater technological complexity, the overall carbon footprint across the product life cycle can be significantly reduced by decreasing the need for multiple purchases and extending the period of use. The paper also identifies current barriers, such as the recycling difficulties associated with multi-layered structures, and proposes the integration of technological innovations, such as Design for Disassembly, as a possible solution. The conclusions highlight that reversible garments represent more than an aesthetic trend; they constitute a model of resource efficiency aligned with the principles of slow fashion and the need to create timeless, durable apparel.*

**Keywords:** Design for Longevity, reversible garments, circular economy, sustainability, resource efficiency, eco-design.

### INTRODUCTION

In a circular economy, the longevity of a garment can be understood from two perspectives: physical longevity, which reduces waste through durability and reliability, and emotional longevity, which reduces the demand for new production through long-term user satisfaction [1]. Reversible products provide an effective case study in which these two forms of longevity converge. These two concepts represent the key pillars of sustainability in product design.

Physical longevity refers to the ability of a garment to maintain its structural integrity and aesthetic appearance over time, despite repeated wear and washing. In the case of double-sided products, this quality is reinforced by their structural integrity. Reversible garments typically require higher-quality materials that look attractive on both sides, as well as more robust construction. Assembly techniques such as closed seams – for example, French seams, flat-felled seams, or bonding – are used to protect the cut edges of the material [2]. This prevents fraying and



makes high-stress areas, such as underarms and pockets, far more resistant than those in a conventional garment. In many cases, the double structure also offers better protection against external factors, helping the garment to retain its shape and resist deformation [3].

Emotional longevity is a strategic design concept concerned with the relationship between the user and the garment. Sustainability does not simply mean that a garment does not break; it also means that the user does not wish to discard it. Aesthetic versatility is central here: a garment with two sides offers a sense of novelty without requiring a new purchase. If one side is neutral and the other is coloured or textured, the garment can respond to different moods and contexts. Such garments also increase satisfaction of choice because the user feels that a smart investment has been made – in effect, two garments in one – which creates a sense of pride and appreciation for the object. Likewise, the phenomenon of “visual fatigue”, which often drives fast-fashion consumption, is reduced. Changing the visible side of the garment refreshes visual perception and extends the period before the wearer feels the need for something “new”.

#### **PURPOSE**

The objective of this research is to identify the advantages of double-sided products within the modern wardrobe and to promote this trend by educating consumers on the environmental impact of fashion, specifically regarding resource consumption during production, utilisation, and disposal.

#### **RESULTS AND DISCUSSION**

##### **Resource Efficiency in the Circular Economy: the “2-in-1” paradox.**

In a linear economy, based on the “take-make-dispose” model, success is measured by sales volume. In a circular economy, by contrast, success is measured by the maximum utility extracted from each unit of resource [4]. From the perspective of material balance, although a reversible garment requires greater material consumption – often two layers of primary fabric instead of a single layer plus a cheaper lining – and approximately double the labour time, owing to the need for impeccable finishes on both sides, it functionally replaces two distinct garments. The environmental impact of producing one reversible garment is approximately 1.5 times higher than that of a standard garment; however, it is estimated to be 25–30% lower than the combined impact of producing two separate garments. Savings are achieved through transport and logistics, as a single unit is shipped instead of two; through packaging, as one product requires less cardboard and plastic; and through energy efficiency, as dyeing and finishing processes are optimised for a single production stream.

From the perspective of Life Cycle Assessment (LCA), the most significant reduction occurs during the use phase [8]. A reversible product is worn more frequently, which lowers the “carbon cost per wear”. In addition, its robust design reduces the need for repairs or premature replacement.

##### **The “slow fashion” approach through versatile design.**

Reversible design acts as a simplification filter in the creative process, forcing a transition from “ephemeral fashion” to “timeless design”.



First, to ensure that a garment is functional on both sides, the designer must eliminate unnecessary decorative elements, which may cause discomfort on the inside, and instead focus on line, volume, and ergonomics. This visual “cleanliness” transforms the product into a wardrobe staple.

Second, the concept of timelessness is highly relevant. Double-faced products tend to avoid aggressive seasonal trends. Their versatility – often expressed through one neutral side and one textured or coloured side – allows them to remain relevant in the wardrobe for years, regardless of fluctuations in fashion. As a result, they become key elements of a capsule wardrobe.

The end-of-life stage of reversible garments, however, remains problematic. If reversibility is achieved by bonding or sewing together two materials with different compositions, such as cotton on one side and polyester on the other, the product becomes extremely difficult to recycle mechanically or chemically. Separating the fibres is costly and technologically complex, which may contradict the principles of circularity unless mono-material solutions are used.

Cost and accessibility also remain major concerns. Highly skilled labour and premium materials result in a higher final price, creating a barrier to entry for the average consumer. The theoretical challenge therefore remains: can reversible design become an industrial standard, or will it remain a luxury niche serving only a narrow segment of conscious consumers?

### **Case studies: reversible design and circular strategies.**

To demonstrate the practical viability of Design for Longevity, two global pioneers may be considered, both of which have successfully integrated reversibility and durability into their business models.

#### **1. Patagonia: the “Worn Wear” and multifunctional strategy.**

Patagonia [5] employs reversible design in several key products, such as items from the Silent Down and Micro D lines. By offering two distinct aesthetic options within a single high-performance garment, the company directly reduces the consumer’s need for multiple purchases.

Through the Worn Wear programme, Patagonia also ensures that these robustly constructed garments remain in circulation for longer. The company’s research indicates that extending the life of a garment by just nine months can reduce its carbon, waste, and water footprints by approximately 20–30% each.

#### **2. Eileen Fisher: “Renew” and timeless versatility.**

Eileen Fisher [6] is a leading example of emotional longevity in practice. Many of the brand’s knitwear pieces and coats are designed according to a “2-in-1” philosophy, whether reversible or modular. The company places particular emphasis on minimalist aesthetics that avoid seasonal trends.

Through the Renew take-back programme, garments that have reached the end of their first life cycle are repaired or redesigned through upcycling. The high-quality construction required for reversible finishes makes these garments well suited to resale, as they retain their structural integrity for far longer than conventional fashion items.



## CONCLUSIONS

In conclusion, although the manufacture of double-sided garments presents challenges related to labour complexity and recycling difficulties, technological innovation offers the necessary means to transform this concept from a luxury niche into a standard of sustainable fashion.

The recycling challenge may be addressed by adopting Design for Disassembly (DfD) principles. The use of smart sewing threads that dissolve at specific temperatures, such as the technologies developed by Resortecs [7], allows the automated separation of material layers at the end of the product's life cycle. This facilitates recycling into mono-material streams, ensuring that the reversible garment is no longer merely a mixture of inseparable fibres but a genuinely circular product.

Reversible products therefore represent more than an aesthetic variation; they constitute an advanced technological strategy. This approach reconciles the consumer's desire for novelty with the imperative of resource conservation and demonstrates that product longevity – both physical and emotional – is a central pillar in the transition towards a truly sustainable fashion system.

Technological innovation is thus the bridge that makes reversible products feasible within a circular economy.

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