

Materials-First and Product-First Approaches to Creating Local, Circular & Bio-based Textiles in the HEREWEAR Project

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Abstract

The HEREWEAR project aimed to establish a sustainable European textile ecosystem by developing locally produced clothing from bio-based materials. Addressing the drawbacks of conventional cotton and polyester, the project piloted cellulose and bio-based polyester textiles at semi-industrial scale. Over 50 prototype garments were created, combining innovative design with small-scale, on-demand production, via regional microfactories. Two design approaches were developed: a Material-First approach, exemplified in this paper by the presentation of the modular *Flexi-Dress* made from wheat-straw cellulose. The design of the dress emphasised multifunctionality and circular lifecycle extension approaches. The Product-First approach is illustrated in the paper by the *Day Shirt*, which was designed to optimise monomaterial construction and recyclability approaches. HEREWEAR demonstrates the feasibility of integrating sustainable materials, design tools, and networked manufacturing to create a European circular, bio-based textile system, offering a practical model for environmentally and socially responsible fashion.

Introduction

What kind of new materials, design and production approaches might we need to develop if we are to evolve a biobased industry where clothes are created, used, reused and recycled in specific geographic regions? How can these clothes be made with less carbon emitted, and with lower chemical pollution from dyes and finishes? How can we ensure that these clothes release fewer microfibres into the water table when washed?

The HEREWEAR project asked questions that run deep in sustainable and circular design discourse. The project resulted in a new model for European regions to have local clothing, made from waste from agricultural waste with little or no value, designed to meet the needs of the people who lived amongst these natural resources. (Buyle *et al*, 2024) The project challenges included overcoming technical hurdles to transforming waste into viable, wearable textiles and designing clothes that would be loved for a long time and kept in use through repair and reselling. The project teams developed a series of prototypes to demonstrate possible responses to these challenges. The design and production process took either a *Materials-First* or a *Product-First* approach. These each represent a transferrable methodology for other interdisciplinary collaborative teams to adopt when tasked with making textiles and clothing that sit outside of existing industry models.

Context

Today, a large amount of clothing is produced in low cost countries, often far away from the brands designing them, under poor labour conditions and with few concerns for the environmental impact (Amed *et al.*, 2022). The vast majority of this clothing is made of two types of fibres; polyester and cotton (Textile Exchange, 2023). These, however, have considerable disadvantages and shortcomings. Polyester is oil-based and involves high carbon emissions, whilst cotton is a water and pesticide-hungry crop. There is therefore a need to divert fashion production from these resources and explore low-impact alternative fibres which reduce pressure on agricultural systems (Fashion for Good, 2025).

The design approaches describe here are set within a broader context of material innovation. As an alternative for cotton, cellulose filaments were made via wet spinning (using the HighPerCell® technology) of biowaste sources such as straw and seaweed was investigated. Instead of using fossil-based polyester, focus in HEREWEAR was on the use of polylactic acid (PLA) mixed with other biopolyesters and processed via melt spinning to yarns. Whilst these new materials are viable alternatives to cotton and polyester, the present different qualities which must be acknowledged and overcome in the design process.

All prototypes within the HEREWEAR project were designed and produced in a holistic approach to advancing bio-based, circular and local textiles and clothing in Europe. This involved digitalization of the development and visualization of concepts, production in digitally connected local microfactory systems, and ensuring transparency and traceability through the Circularity.ID a digital product label developed by project partner circular.fashion. The Material-First and Product-First approaches were both set within these parameters of collaboration and circular design.

Materials-first and Products-first Approaches

Within the HEREWEAR project, the fashion brand VRETENA developed two prototype scenarios for ready-to-wear, urban garments designed to transition seamlessly “from Work to Streets”. These

scenarios applied two distinct design methodologies: a Material-First Approach, in which the garment is created in direct response to the properties of a novel material, and a Product-First Approach, in which new bio-based fabrics are developed to replace the materials of an existing garment design. The fabrics envisioned for these scenarios included a bio-based knit and a woven textile, both intended as sustainable alternatives to conventionally used fibres such as cotton.

The development process followed six structured steps:

1. Creative exploration using design guidelines and supporting tools.
2. Early prototyping to assess materials and production techniques.
3. Materials sampling to explore the performance of candidate fabrics.
4. Circularity checks and local modelling to ensure alignment with HEREWEAR criteria.
5. Digital design and simulation to test prototypes and prepare for production.
6. Creation of tech packs for implementation in the manufacturing stage.

The Flexi Dress: A Material-First Approach

The Flexi Dress was conceived as a response to HighPerCell® material from wheat straw, a bio-based cellulose fibre derived from unbleached wheat straw, which naturally exhibits a warm golden hue. This material emphasis created both an emotional and aesthetic connection to the fibre, while also advancing circularity through the avoidance of bleaching or dyeing steps.

The Flexi Dress (Figure 1) was designed as a versatile knitted garment that could be worn in multiple ways: as a complete dress, a separate top and skirt, or reversed to vary the neckline. This multifunctionality supports lifecycle extension by enabling the wearer to adapt the garment for different contexts. The design incorporated zero-waste pattern strategies and monomaterial construction, eliminating trims and additional hardware to facilitate recycling. Extensive knitting trials were undertaken to engineer joinable and separable garment parts without the use of additional fasteners. The resulting structure employed knitted slots and a belt system with denser knit zones for modesty.

The garment combined a modular construction, a silky tactile quality, and the inherent beauty of the unprocessed natural fibre. Its innovative approach was recognised with an award - Cellulose Fiber Innovation of the Year 2024 Award - at the 2024 Cellulosic Fiber Conference in Cologne, Germany.

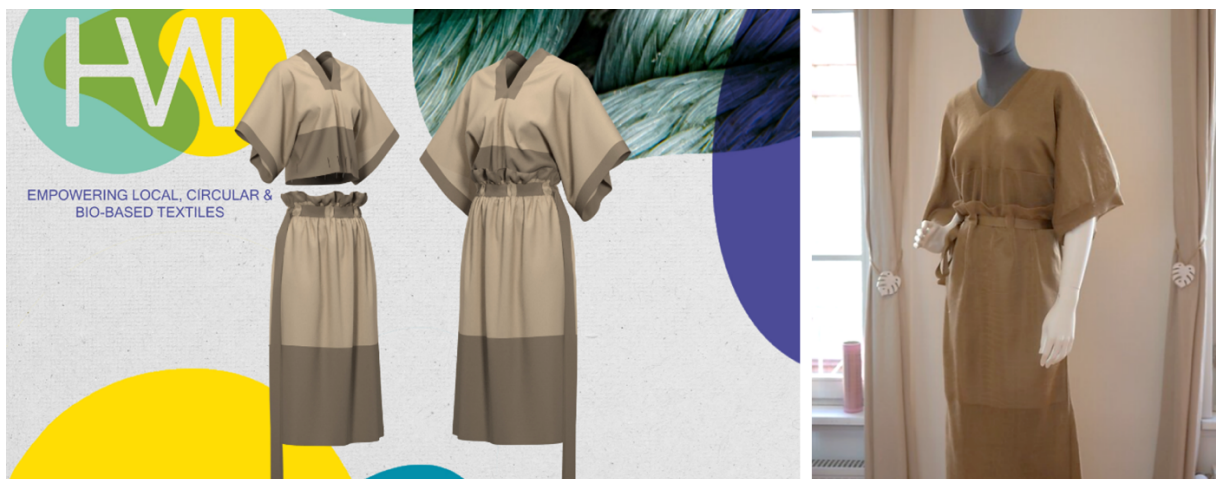


Figure 1: The Flexi Dress 3D Design and garment simulation tool (left) and garment prototype (right)

The Day Shirt: A Product-First Approach

The Day Shirt was developed by re-imagining an existing VRETENA design originally produced in organic cotton. The aim was to replace this with a novel biopolyester woven material, demonstrating its potential as a breathable, skin-friendly and recyclable alternative.

Design-for-circularity principles were embedded into the garment: a monomaterial strategy was applied, and trims such as interfacing and buttons were removed. These choices facilitated recycling, while the aesthetic was deliberately positioned as a comfortable yet smart shirt with long-term emotional value.

A central technical challenge lay in overcoming the common drawbacks of biopolyester fabrics, which often feel stiff or “crunchy.” Through iterative material trials and close collaboration between partners, a satin-woven biopolyester fabric was developed, achieving improved softness, drape, and coverage. The final prototype (Figure 2), produced in a pale sage green, demonstrated that biopolyester can achieve both performance and aesthetic qualities suitable for ready-to-wear applications.

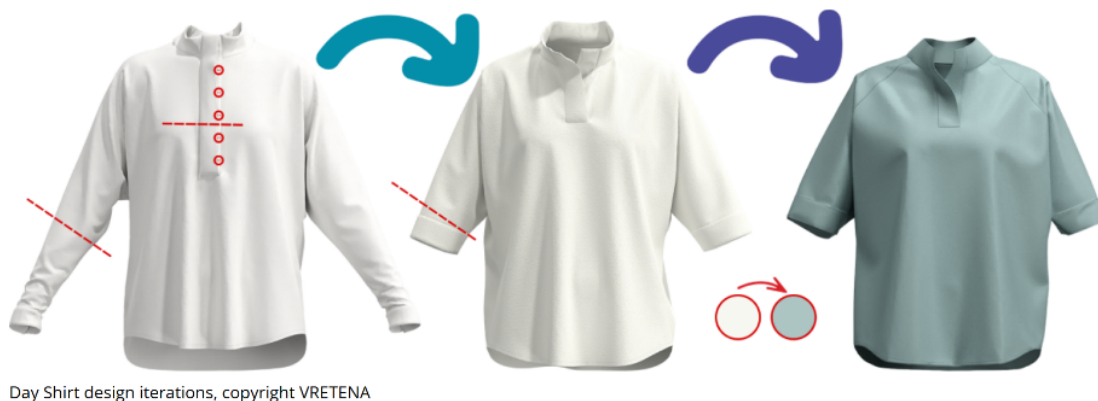


Figure 2: The Day Shirt - 3D Design and garment simulation tool

Conclusion

The HEREWEAR project has demonstrated that a sustainable European textile ecosystem can be advanced through the integration of bio-based materials, innovative design methods, and localized production models. At the material level, cellulose filaments derived from wheat straw and bio-based polyesters such as PLA were successfully developed and piloted at semi-industrial scale, offering credible alternatives to conventional cotton and fossil-based polyester. On a product level, prototypes demonstrating the wearability and desirability of these new fibres were developed.

The two design approaches explored — Material-First with the Flexi Dress and Product-First with the Day Shirt — highlighted complementary pathways for embedding sustainability into fashion. The former emphasized how new materials can inspire multifunctional, modular designs, while the latter demonstrated how existing products can be re-imagined with bio-based textiles to enable recyclability and extend usability. Both prototypes underline the importance of design as a lever for circularity.

A further cornerstone of the project is the HEREWEAR Hub (2024), established as a central platform for knowledge exchange, design guidelines, digital tools, and material libraries. By connecting diverse actors in the textile value chain, the Hub fosters collaboration, supports the adoption of circular and bio-based practices, and ensures that the project's outcomes are accessible and scalable beyond its duration.

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