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BioTEN BURRR: Exploring current use, reuse, repair and recycling practices for bio-based clothing towards guidelines for circular fashion designers

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The HEREWEAR project is building a holistic, systems approach towards the creation of an EU market for locally produced textiles and clothing made from bio-based resources. New material solutions have been building on the latest bio-based polyesters and cellulose developments, exploring agricultural waste or bi-product (mainly wheat straw, plentiful in northern Europe) for making cellulosic textile fibres. Working in tandem with technical material research actions, design and manufacturing is being explored via the creation of garment prototypes for streetwear and corporate clothing. The use phase and end-of-life processing management – use, re-use, repair and recycle – is also being explored, to understand how new design approaches and business models might support this. This paper uses the BIO TEN framework currently being developed (Earley and Forst, Forthcoming), to support the translation of lived experiences of working with bio-based materials into recommendations for the design and production of bio-based clothing which considers extended use phases. The BIO TEN gives structure to information, inspirational case studies and specific actions offered to the industry stakeholders. In particular, the framework supports an enhanced definition of *remanufacturing* as a lifecycle extension strategy, in contrast to its conventional positioning in the field of recycling. The methods for this study included a literature review covering existing guidelines, a practice review of the work of Mai bine, a small social enterprise in Iasi, Romania, interviews with early adopters (Romanian designers experienced in working with bio-based materials), and BURRR workshops with these designers, as well as students in London (BURRR is short for Bio / Use / Reuse / Repair / Recycle).

The literature review process collated current design guidelines for product longevity. Four key reports enabled a better understanding of the current scope of recommendations for life cycle extension: Ellen MacArthur Foundation's '*New Textiles Economy*'(2017), Nottingham Trent University's '*Durability Dozen*'(Cooper *et al.*, 2021), WRAP's '*Sustainable Clothing: A practical guide to enhancing clothing durability and quality'*(2017)*, and* Institute for Positive Fashion's '*The Circular Fashion Ecosystem, A Blueprint for the Future'*(2021). This review highlighted the absence of guidelines that are specific to novel bio-based materials therefore pointing to a need for recommendations that can support designers in using these materials in circular design.

The practice review with Mai bine, showed that the lifecycle extension part of circularity includes the recovery and remanufacturing of clothing for a new use, and that this approach is different to recycling in which fibres are recovered as a raw material. It was also made apparent that different materials behave differently in this remanufacturing process.

The interviews with five early adopters, revealed key insights from the lived and professional experiences of bio-based man-made cellulosic fibres. These can be arranged under four themes: [1] Availability of the materials [2] Quality of the materials [3] Price of the materials [4] End of life options of the materials.

The insights produced through these interviews and the BURRR workshops took the form of practical recommendations based on the participants' experience. They were written up to align with the Bio TEN framework. These guidelines are aimed at fibre, textile and garment manufacturers and designers and encourage them to also build comprehensive communications and collaborations with marketing personnel, inside organisations and externally.

Support tools in the design process are generally tested by their developers (Roy and Warren, 2019), connecting directly with the users of biobased materials to test the BIO TEN guidelines is therefore a necessary step for their effective diffusion in the fashion textiles industry. By translating the insights from the interviews and workshops to practical prompts relating to circularity, both in terms of resource recovery and product longevity, using the BIO TEN framework, the guidelines are grounded in designer's experience. For instance, in relation to [2] and the quality of biobased materials, BIO TEN 5 'Design for Circular Lifecycle extension: Design for durability' offers a range of recommendations around product-specific physical durability, emotional durability, or repairability. The other points listed above also relate to the BIO TEN.

The next steps for the HEREWEAR project are the development of a software tool which will include a full set of inspirational case studies and guidelines to support the design of bio-based fashion garments. Further referencing the experience of designers with the guidelines will help the industry to take-up these results.

Key words: circular economy; repair; bio-based materials; textiles; clothing

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