HSLU Lucerne University of Applied Sciences and Arts

Design Film Art
Products & Textiles Research Group

A DESIGN GUIDE FOR CIRCULAR DESIGN STRATEGIES FOR TEXTILE PRODUCTS

Version 2

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The Products and Textiles research group of Lucerne University of Applied Sciences & Arts - School of Design, Film and Art conducts applied research in the field of design and sustainability. Its research is based on scientific concepts that are reflected in practice and is committed to a systematic and circular approach. The research group is interdisciplinary in its methods and composition and its skills range from textile and product design to historical research and environmental sciences. The activities encompass applied research in transdisciplinary settings with partners from industry as well as providing advice and guidance to public institutions. Communicating its findings, building networks and striving for a relevant impact to the transition of the textile sector towards more sustainability.

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The present publication is based on the ongoing applied research project Circle up Textiles CUT, conducted by a project team comprising researchers from the Research Group Product & Textiles at the Lucerne University of Applied Sciences and Arts together with Swiss industry partners across the textile value chain. It is further informed by insights gained from two circular pilot collections.

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Glossary

DESIGN MODEL FOR CIRCULAR TEXTILE DESIGN STRATEGIES VERSION 2

The Design Model Version 2 is based on the ‘Design Decision Tool for Sustainable Product Development’ (Adler et al., 2021), offering a graphic depiction of possible fields of action in design throughout the product life cycle, in the six phases MATERIAL STRATEGY & PRODUCTION (1), USE (2), EXTENDED USE (3), RE-USE (4), RECYCLING (5) and END OF LIFE (6)

DESIGN STRATEGIES

Design strategies are overarching corporate specifications for the design of collections and individual products. The five design strategies (3–7), which are geared towards sustainability and circularity and have an impact on improved product sustainability, show varying degrees of interdependence throughout the product life cycle. Different interdependencies come into play depending on which overarching circular design strategy is chosen. The interdependencies are represented in the design model with radial connections.

FIELDS OF ACTION

Areas for design action to achieve product circularity. The fields of action are divided into six consecutive phases of the product life cycle and can be combined or complemented according to the design strategy.
Existing knowledge within the scientific community is presented and referenced here. In addition, practical applications and design decisions are presented in the form of specific instructions.

PRACTICAL APPLICATION

Applied design practices of industrial partners in the CUT research project (where available) to provide inspiration and practical references to the research body. Specific guidelines help designers make decisions that lead to a circular product design.

ESPR DRAFT REQUIREMENTS

In this Design Guide, the term ‚ESPR draft requirements‘ is used to denote particular extracts from the publication ‚Draft of new product priorities in the Ecodesign for Sustainable Products Regulation, ESPR‘ (European Commission, 2023) that pertain to textile products within their respective product lifecycle phases. The requirements are part of a proposed ESPR working plan that is aligned with the ESPR regulation that came into force in June 2024.

User Manual

The objective of this design guide is to provide information to designers and decision-makers within the company involved in product development, management and marketing (hereinafter referred to as 'DESIGN'). The goal is to make informed design decisions in the development of cascading-circular products and product life cycles in order to achieve a reduction in the consumption of virgin resources and the resultant environmental impact.

Five design strategies are taken into consideration: PRODUCT CIRCULARITY, APPROPRIATE LIFESPAN, MATERIAL CIRCULARITY, MATERIAL HEALTH and EFFECTIVE PRODUCTION.

From a theoretical, practical and regulatory standpoint, this design guide

- provides the scope for design in the development of cascading circular products in the form of fields of action,
- shows the interdependencies between the individual fields of action along a product life cycle in six phases,
- highlights exemplary design decisions that must be made for the practical application of the fields of action, enumerates the ESPR draft requirements for potential design interventions,
- and presents detailed steps in the form of a 'reverse logistics checklist' for establishing a reverse logistics system that supports circularity.

The life cycle of a circular product is structured in six lifecycle phases: MATERIAL STRATEGY & PRODUCTION (1), USE (2), EXTENDED USE (3), RE-USE (4), RECYCLING (5) and END OF LIFE (6). These phases are interdependent, occur sequentially in cascading cycles throughout the product's entire life cycle and must be defined in the initial design. Designers can take these successive phases into account in the design of the product including the cascading use cycles.

In the MATERIAL STRATEGY & PRODUCTION phase, sustainable material strategies are developed and manufacturers are involved who have the expertise to translate circular design strategies into sustainably sourced products and manufacture them as resource-efficiently as possible. General material strategies based on current literature on preferred fibres are presented to complement the information from the specific fields of action.
General material strategies based on current literature on preferred fibres are presented to complement the information from the specific fields of action.

In the USE and EXTENDED USE phases, the responsibility for the appropriate intensity and duration of use lies with the customer. Here, DESIGN provides recommendations and incentives for ensuring circular use and can offer touchpoints to extend the product's life cycle. From the RE-USE phase to the END OF LIFE phase, industry regains sovereignty over the product. Ideally, the necessary course for extending a product life along the phases is set by

DESIGN in the initial design. Be it in the form of a curation for reuse of the product, the design of sub-products for remanufacturing or a material selection and combination tailored to the process steps of the different recycling technologies. Designing products and their respective product life cycles in a cascading circular fashion is required and sensible for a sustainable future. In addition, a circular product design ensures compliance with new EU regulations that must be considered for products sold on the European market in the near future.

In collaboration with all stakeholders, DESIGN acts as a hub for the entire life cycle of a cascading-circular product: DESIGN makes necessary decisions that affect the different lifecycle phases in the initial design, accompanies users during the use phase by creating incentives for longer product use and formulating specific instructions for returning the product to the industry. Furthermore, DESIGN determines how much material can be recycled at the end of the product's life through the choice of materials, material combination and selected finishing and treatment processes.

Version 2

DESIGN MODEL FOR CIRCULAR TEXTILE DESIGN STRATEGIES

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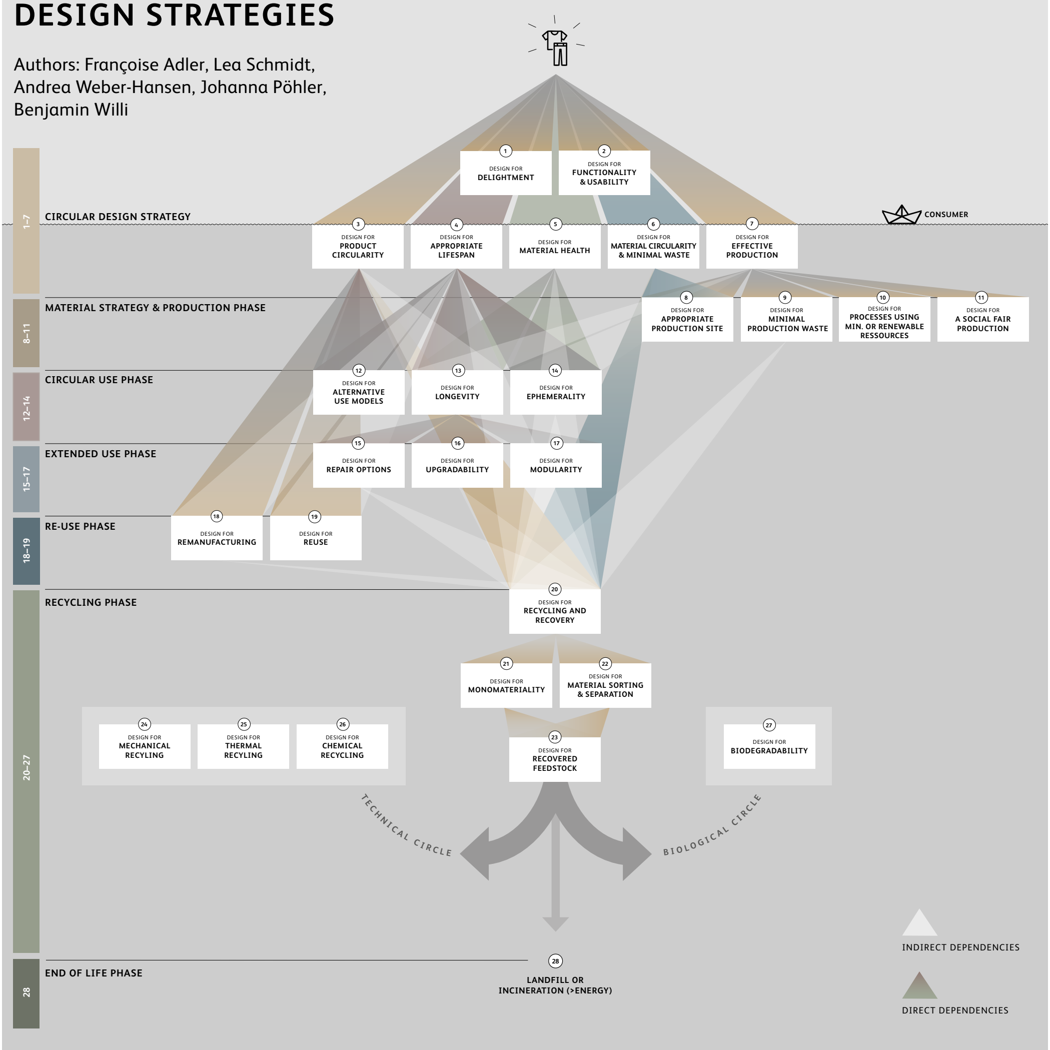

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CIRCULAR DESIGN STRATEGIES

The design strategies DESIGN FOR DELIGHTMENT (1) and DESIGN FOR FUNCTIONALITY AND USABILITY (2) are classic design strategies that are universally applied and are not accompanied by an explanation of design practice in this guide. Design strategies 3–7 DESIGN FOR PRODUCT CIRCULARITY (3), DESIGN FOR APPROPRIATE LIFESPAN (4), DESIGN FOR MATERIAL HEALTH (5), DESIGN FOR MATERIAL CIRCULARITY AND MINIMAL WASTE (6) and DESIGN FOR EFFECTIVE PRODUCTION (7) are geared towards sustainability and circularity and complement the first two design strategies. A design practice section has been added to provide inspiration and concrete examples.

1 DESIGN FOR DELIGHTMENT

The design of a product is a key factor in determining whether consumers will find it enjoyable to use. This enables consumers to establish a positive relationship with the product, thereby fostering a desire to utilise it extensively and over an extended period of time (Chapman, 2009; Bocken et al., 2015). The attainment of emotional longevity can be facilitated by a number of factors, including personalisation and meaningful contextualisation.

2 DESIGN FOR FUNCTIONALITY & USABILITY

The product‘s handling, utilisation and functionality are adapted to the needs and expectations of the customers. User-oriented product usability increases customer satisfaction and product value and sometimes determines whether a product is used for as long as possible. (Shedroff, 2009, p. 188 ff)

3 DESIGN FOR PRODUCT CIRCULARITY

The product is designed in such a way that it can circulate as a product (suitable for reuse), as a sub-product/ semi-finished product (suitable for remanufacturing) or as a material (suitable for recycling). Cycles must be kept as short as possible (priority: reuse > remanufacture > recycling). The materials used and the production steps are transparent.
This enables customers to make an informed purchase decision with regard to materiality and simplifies a subsequent recycling process. (Bakker et al., 2014, p. 83; McDonough & Braungart, 2010, p. 55 ff; Circle Economy, 2020; Niinimäki, p. 35 ff, 2018; Webster, 2017; Balkenende & Bakker, 2018; Shedroff, 2009, p. 277 ff; UAL et al., no date -a)

Practical Application: The design strategy for product circularity is based on transparency in production (material consumption/ individual production

steps) and on functioning return processes (collectors or in-store). In the USE phase, it requires high material and manufacturing quality of the products (LONGEVITY) so that they can be used in the EXTENDED USE phase. Furthermore, ALTERNATIVE USE MODELS are a prerequisite to enable repair (REPAIR OPTIONS), upgrade (UPGRADABILITY) or replacement of sub-products (MODULARITY) in the EXTENDED USE phase. In the RE-USE phase, in addition to the alternative use models, the return processes are key so that products and sub-products can be REMANUFACTURED or RE-USED.
The following decisions could support this field of action:

- Use high-quality raw materials, select a timeless design and colour concept, and/or adopt a one-size-fits-all approach to support longevity during the use and extended use phases already at the design stage
- Use removable sub-products (buttons, zips, trims) to support EXTENDED USE and ALTERNATIVE USE models
- Embed product circularity as a mandatory requirement from the outset – across planning, sourcing, material selection, and product development
- Use QR codes, social media, labels and/or digital content to transparently communicate care instructions, repair instructions, material and manufacturing information to support USE; EXTENDED USE AND ALTERNATIVE USE MODELS

4 DESIGN FOR APPROPRIATE LIFESPAN

The design, material and function are optimally matched in terms of their lifespan. Thus, the intensity of use of a product align with the stability and robustness of the material. The lifespan of the product must be clearly communicated to customers (Niinimäki & Hassi, 2011; Tischner, 2014). The expenses for production and recycling are proportional. (Goldsworthy, 2018)

Practical Application: The appropriate lifespan design strategy requires a balance between a product's style, the quality of its materials the effort invested in its manufacturing, and it's duration of use. This careful balance is communicated to users in a way they can understand. A mismatch/disbalance between the four aspects lead to a loss of resources and materials for both short-lived (ephemeral) and long-lasting products. The guiding question of an appropriate lifespan is: does the length of the chosen product life align with the stability and robustness of the material and the effort invested in its manufacturing? The brands' sustainability guidelines (for buyers and designers) describe this careful balance for their products.
The following decisions could support this field of action:

- Establish and apply standardized testing methods for determining product lifespan
- Determine the appropriate product lifespan by aligning style, material quality and workmanship, taking into account usage patterns and wash cycles

- Align material costs and manufacturing efforts according to the defined product lifespan
- Communicate determinded lifespan of the product to users

5 DESIGN FOR MATERIAL HEALTH

Harmful substances are avoided – 'design them out' (MacArthur, 2017). They are a burden on the global ecosystem, affecting flora, fauna and humans, and may only be handled in closed technical cycles. Harmful substances also include those that are by-products of the manufacturing process. (e.g. pesticides, auxiliary materials, wastewater, slag). (Haffmans et al., 2018; McDonough & Braungart, 2010, p. 32 ff, p. 42 ff; Shedroff, 2009, p. 225 ff; UAL et al., no date)

Practical Application: The Material Health design strategy prioritises the minimal and biological use of chemicals and avoids harmful substances such as those on the AFIRM Group's Restricted Substances List (RSL). DESIGN FOR MATERIAL HEALTH selects dyes that are neither ecotoxic nor toxic to humans. For example, preference is given to dyes with high fixation and, as far as possible, without metal complexes (as are often used for black, for example). Textile chemicals should be used sparingly and, where possible, kept in closed technical cycles. In addition, DESIGN FOR MATERIAL HEALTH adheres to the ZDHC positive list (list that does not contain harmful ingredients) in product development and complies with the European Union's REACH regulations. Harmful substances are continuously assessed along the value chain. Guidelines for the disposal of hazardous substances must be observed during product development and clearly communicated to suppliers.
With a focus on biodegradability, DESIGN FOR MATERIAL HEALTH uses exclusively natural, biodegradable materials from the outset, such as natural dyes for colouring.
In addition, environmentally friendly processing technologies that use little or no water or chemicals are preferred: laser or ozone technology instead of grinding or bleaching processes, enzymatic washing for a softer feel, or nano-bubble technology to efficiently apply softeners, resins or dyes to the textile. The use of high-quality textile materials eliminates the need for washing and improves the feel of the product. Certifications such as Cradle to Cradle, which require the use of materials and processes with a lower impact on the ecosystem, support the material health design strategy.
The following decisions could support this field of action:

- Choose processing technologies that use little or no water or chemicals like laser or ozone technology instead of grinding or bleaching processes, enzymatic washing for a softer feel, or nano-bubble technology to efficiently apply softeners, resins or dyes to the textile
- Research and substitute substances that are ecotoxic or toxic to humans with materials listed on the ZDHC positive list or AFIRM Group's Restricted Substances List (RSL)
- Research and implement dyes and appropriate printing methods that minimize or eliminate the use of hazardous chemicals, such as metal

complexes while ensuring high fixation rates
- When designing for biodegradability use exclusively biodegradable materials from the outset, such as natural dyes for colouring

6 DESIGN FOR MATERIAL CIRCULARITY & MINIMAL WASTE

The product is designed to minimise waste, in the sense of material that is not further utilised within the biological or technical cycle. This must be taken into account during the manufacturing process, encompassing the packaging stage, the utilisation phase, the extended use phase, the recycling phase, and at the 'end of life'. If materials cannot be returned to a biological or technical cycle, they must be disposed of in the best possible and most specific manner. (MacArthur, 2017; McDonough & Braungart, 2010, p. 104 – 115; Rockström, 2009; Runnel et al., 2017; Shedroff, p. 249 ff., 2009)

Practical Application: The material circularity and minimal waste design strategy focuses on returning materials and products either to the biological or technical material cycle. Transparent supply chains and functional return processes (by collectors or in-store) are key to ensuring return and enabling reuse. All materials used in the product right through to the packaging (textiles, sewing threads, trims) are used to be circular and recyclable from the perspective of DESIGN FOR MATERIAL CIRCULAITY AND MINIMAL WASTE. There are three fields of action for this: all materials are biodegradable (DESIGN FOR RECOVERED FEEDSTOCK), all materials can be separated (DESIGN FOR MATERIAL SEPARATION) or the materials used are monomaterials (DESIGN FOR MONOMATERIALITY). In the DESIGN FOR MATERIAL SEPARATION field of action, DESIGN also ensures that products can be easily separated into their sub-products, that a recycling technology is available for these sub-products and that as little waste as possible is generated during production. The use of Cradle-to-Cradle-certified materials supports material circularity.
The following decisions could support this field of action:

- Source recycled materials, prefer textile-to-textile whenever possible.
- Optimise production process to minimize waste along all process steps
- Establish material cycles and take-back processes for your product to ensure that materials are effectively reintegrated into the cycle
- Align the product according to requirements from chosen material cycle (e.g. regarding material quality, use of chemicals, and processes with minimal ecological impact) and build strong supplier relationships to ensure transparency and good circular practices
- Minimise material complexity in products and, wherever possible, use monomaterials
- Ensure the separability of different materials in line with the requirements of recycling technologies
- Regularly train employees in circular design and material strategies, recyclable materials, and relevant EU regulations, targeting design, marketing, sustainability, and sourcing teams at the early stage of development

7 DESIGN FOR EFFECTIVE PRODUCTION

Resources, auxiliary materials, water, textile materials and energy required in production are used as effectively as possible in the sense of Braungart (McDonough & Braungart, 2010, pp. 157—186) and production waste is minimised. In addition, the investment in resources, auxiliary materials, energy and water in production is proportional to the lifespan of the product. (Fletcher, 2004; Stebbing & Tischner, 2015)

The following decisions could support this field of action:

- Build long-term relationships with manufacturers and collaborate to optimize production efficiency
- Evaluate whether certain substances can be eliminated or minimised, and how materials and auxiliary inputs can be reduced or saved in the product.
- Evaluate production processes for potential savings in energy and unwanted substances and test alternatives such as laser technology for fading or finishing instead of chemical and water-intense finishings
- Actively seek access to primary data on raw materials, components, and other materials to enhance transparency and support the planning and evaluation of circular design strategies

MATERIAL STRATEGY & PRODUCTION PHASE

The Material Strategy & Production phase is where important decisions are made that have a major impact on the environmental footprint. It is also in this phase that the product life extension cascades (extended use, reuse and recycling) are established. The fields of action here are APPROPRIATE PRODUCTION SITE, MINIMUM PRODUCTION WASTE, PROCESSES USING RENEWABLE RESOURCES and SOCIAL & FAIR PRODUCTION.

8 DESIGN FOR AN APPROPRIATE PRODUCTION SITE

Minimisation of transport distances and creation of local added value. (McDonough & Braungart, 2010, p. 123 ff; Stebbing & Tischner, 2015)

Practical Application: The choice of local or regional value chains must be made consciously. Regional value chains can increase transparency and reduce transport. An important factor is the choice of textile raw materials, which should be sustainably sourced and/or recycled and allow for traceability. Appropriate material strategies need to be defined in the context of the chosen design strategy.
The following decision could support this field of action:

- Research local or regional production sites to reduce transportation and enhance traceability

9 DESIGN FOR MINIMAL PRODUCTION WASTE

The product is manufactured with as little waste as possible (e.g. minimal offcuts). Where possible, cycles are closed (water, chemicals). Inorganic and organic substance groups that cannot be further used as nutrients in biological or technical cycles must be disposed of appropriately without causing additional harm to the ecosystem. (Runnel et al., 2017)

Practical Application: Production waste is avoided and reduced as far as possible by returning post-industrial waste to the production processes or reusing it (e.g. spinning mill waste for recycled yarn). Pattern making, placement and cutting is optimised to minimise cutting waste, through zero waste pattern design. Denim fabric is left raw and is neither chemically nor mechanically pretreated. Appropriate specifications shall be provided to the supplier.

Overproduction is avoided by accurately planning the quantity to be produced and not ordering additional products as standard. Planning values are established and discussed with the supplier.

The following decisions could support this field of action:

- Build long-term relationships with manufacturers and collaborate to optimise production waste
- Optimise pattern making, placement and cutting to minimise cutting waste
- Plan quantities accurately to avoid overproduction
- Systematically track and document production waste to identify impactful reuse opportunities, (e.g. spinning mill waste for recycled yarn)

10 DESIGN FOR PROCESSES USING RENEWABLE RESOURCES

The energy required for production and transportation is derived from local, renewable energy sources. The product is processed in a manner that conserves water and resources are utilised as efficiently as possible during the production process. (McDonough & Braungart, 2010, p. 132 ff)

Practical Application: The efficient utilisation of energy, water and other auxiliary materials constitutes a pivotal element in the sustainability of the product. It is important that resources are recirculated wherever possible. To illustrate this point, one may consider the reuse of water used in finishing processes that have only been slightly soiled. Energy should be generated from renewable sources, such as photovoltaic (PV) or heat networks. These issues are considered when selecting suppliers. In an effort to minimise carbon emissions, local value chains are to be favoured wherever practicable, given their tendency to necessitate reduced transportation.

11 DESIGN FOR SOCIAL FAIR PRODUCTION

The manufacturing of a product and its constituent materials is conducted under equitable conditions, thereby engendering sustainable benefits for society and fostering favourable living conditions. Paid wages enable a good quality of life and working hours are regulated accordingly. The well-being of employees is a matter of concern, and the right to engage in trade union activity is recognised. (Fashion Revolution, 2020)

MATERIAL STRATEGIES

The selection of materials and the corresponding material strategy play a critical role in determining a product's circularity and overall environmental impact. To support companies in adopting more sustainable material practices, Textile Exchange has introduced the concept of 'Preferred Fibres', which emphasises the use of sustainably sources and recycled fibres. These criteria define fibres that exhibit reduced impact on climate, ecosystems, and human well-being compared to conventional alternatives (Textile Exchange, 2023).

In addition to the deliberate selection of materials, the combination of materials within a product is a critical factor influencing its circularity. Hall et al. (2023) identify various blending strategies within the textile sector, noting that materials can be combined at the yarn, material and product levels. They further distinguish five levels of blending complexity based on fibre types (animal, plant and synthetic). These include monomaterials (no blending), subtle blends (combinations of similar fibre types, e.g. wool and alpaca), cycle blends (combinations within a single cycle, e.g. wool and cotton), hybrid blends (combinations of biological and technical cycles, e.g. wool and acrylic), and complex blends (combinations of plant-based, animal-based and synthetic fibres).

Practical Application

Material blends are widely employed in the textile industry to enhance functional properties, such as durability, comfort, and performance. However, these blends simultaneously complicate, and in some cases hinder circular use – particularly recycling – across different stages of the product lifecycle. Consequently, a deliberate and reduced selection of materials right at the product design stage is essential to facilitate circularity.

- Use preferred fibres in textile products (e.g. mechanically recycled cotton) to reduce environmental and social impacts
- Select materials in alignment with a defined end-of-life strategy (e.g. polyester-monomaterial suitable for thermo-chemical recycling)
- Avoid material blends composed of different fibre types, as these are generally difficult or impossible to separate during recycling processes
- Prioritise the use of organic or recycled fibres and/or materials certified for sustainable sourcing or recycled fibres

CHECK WITH ESPR DRAFT **REQUIREMENTS MATERIAL STRATEGY & PRODUCTION PHASE**

Choice of materials and restrictions on substances:

- Avoiding the use of coatings
- Avoiding hazardous substances that cause material streams, not to meet the requirements to be recycled and reused in new products in the future
- Avoiding design choices hindering recycling (e.g. multilayers, etc.)

Use of standard components:

- Use of shared solutions, fittings, and parts
- Use of standardised material and recommended colours Number of materials and components used

(European Commission, 2023)

USE PHASE

The USE PHASE should be designed to enable the longest possible product lifespan within its first life cycle, as well as subsequent cascading uses. This also includes care and usage instructions for consumers, who assume responsibility for the product during this phase. The fields of action in this phase are DESIGN FOR ALTERNATIVE USE MODELS, FOR LONGE-VITY, FOR EPHEMERALITY.

12 DESIGN FOR ALTERNATIVE USE MODELS

The design of products for alternative use models can encompass a variety of services and systems, including rental systems, subscriptions, intangible products and libraries. The DESIGN FOR ALTERNATIVE USE MODELS develops models for the ownership of products, associated services and systems, with a focus on aligning with user needs. (Buchanan, 2001; Fontell, 2017; Krippendorff, 2011)

Practical Application: ALTERNATIVE USE MODELS enable brands to develop new business models (B2B, B2C) beyond traditional retail and linear product ownership. They require distinct design decisions. In shared wardrobe or rental models, customers rent clothing instead of purchasing them outright. This concept presupposes high-quality materials and workmanship, adjustable fits for diverse body types, as well as excellent washability and repairability. In a material ownership or subscription models, the material remains the property of the brand, while the product is used within a subscription scheme, with the intent of reclaiming and recycling it at the end of life. This concept requires design with a strong focus on optimised recyclability and the active engagement of customers return logistics must be carefully planned and communicated to ensure a reliable and traceable material flow within alternative use models between users and the brand.

In both models, product take-back by the brand is of central importance. Return logistics and processes must be carefully planned and clearly communicated in order to ensure a reliable and traceable material flow between users and the brand. Strong and consistent communication is essential to enable users to perceive themselves as active participants in a circular value chain. Workshops, swap events, promotions, and bonus-based return systems further strengthen and expand alternative use model offerings.
The following decisions may support this field of action:

- Consider alternative use models beyond traditional retail and product ownership, such as shared wardrobe/rental or material ownership/subscription models

- In material ownership models, ensure that products are optimised for recycling and embedded in functioning take-back systems
- In shared wardrobe/rental models, ensure that products are made from high-quality materials and workmanship, adjustable fits for diverse body types, as well as excellent washability and repairability
- Clearly communicate the user‘s new role within the circular value chain – including take-back processes – in order to support alternative use models

13 DESIGN FOR LONGEVITY

The workmanship and materials of a product and all its individual parts are designed for a long lifespan (Fletcher, 2004; Goldsworthy, 2018). This facilitates high resource effectiveness, thereby ensuring the attainment of high material and product quality. (Bakker et al., 2014, p. 83; Cooper et al., 2013; Karell & Niinimäki, 2019)

Practical Application: The ‘Longevity’ field of action focuses on products with timeless designs and colours in addition to the utilisation of high-quality materials and meticulous workmanship. The product‘s multifunctionality is achieved through its reversibility or dual functionality (for example, warming-cooling, fancy-classic, etc.). A long-lasting product requires a good brand-product relationship (technical) and/or a user-product relationship (emotional). Longevity requires repairability. Spare parts must remain available (NOS: never out of stock). Maintaining the value of the product is key. This principle pertains to both the design process and the selection of materials. Longevity is a prerequisite for both the ‚Extended Use‘ and the ‚Re-Use‘ phases. The quality of the textile material is not diminished by interventions such as artificial material damage (rips), or fading (sanding, peach), with the objective of averting an unnatural weakening of the source product. The textile material and the functional and designed ‘trims’ are of equally high quality. Informative communication is needed to ensure that customers are able to handle durable products effectively (e.g. by adding this information to the care label). The following decisions could support this field of action:

- Focus on higher quality, and durable, repairable materials such as heavier organic cotton fabrics
- Reduce product lines and develop design strategies for emotional and functional longevity, including timeless cuts, age-graceful aesthetics, extended use phases, and built-in repair options
- Provide information for a digital product passport, such as material information (e.g., sewing thread, labels, hard parts, etc.), supply care instructions, care kits, and replacement parts, and integrate appropriate equipment for maintenance and lifespan extension

14 DESIGN FOR EPHEMERALITY

The product‘s style, the quality of its materials the effort invested in its manufacturing are designed for a short lifespan (Fletcher, 2004; Goldsworthy, 2018). Within Design for Ephemerality cycles are designed for a short lifespan. The resources required for production, transportation and recycling are kept to a minimum. Processing and material selection are designed to ensure that the product can be optimally recycled and, ideally, composted. (Haffmans et al., 2018, p. 67 ff).

Practical Application: The ‚Ephemerality‘ field of action describes short-lived products and sub-products. These range from disposable products (e.g. medical Protective Equipment) to those subject to rapidly changing fashion cycles. Ephemeral products require minimal resources in terms of materials, processing and recycling. Ephemeral products can be integrated into either a biological or a technical cycle. In a biological cycle, exclusively biodegradable materials should be used. In a technical cycle, monomaterials or recyclable blends support recyclability, and the requirements of the chosen recycling technology – whether chemical, enzymatic, or mechanical – must be carefully considered. Also in the technical cycle, renewable material resources should be preferred. Alternatively, existing stock (remaining quantities) can be utilised. Furthermore, the presence of problematic chemicals should be avoided as a matter of principle in this strategy. The environmental impact of short-lived products should be minimised wherever possible. Ephemeral accessories/trims are defined as independent sub-products with a capacity for repeated use (in conjunction with a durable main product) and are offered to users in the form of new use models.
The following decisions could support this field of action:

- For ephemeral design strategies, use materials that are fully compatible with the intended recycling strategy, e.g. mechanical recycling, chemical recycling, thermal recycling or biodegradability
- Use minimal resources in terms of materials, processing and recycling

CHECK WITH ESPR DRAFT **REQUIREMENTS USE PHASE**

Minimum lifetime and labelling:

- Labelling on the minimum (technical) lifespan / Mean Time Before Failure (MTBF)
- Lifespan guarantee (different parameters: e.g. number of years/hours/cycles)
- Definition of the test methods and reporting standards

Minimum durability of function:

- Information how long a particular (given) product functions would last under known use and/or aging effects / „fitness for use" (repellence, flame retardance, colour fastness, dimensional changes)

Resistance to stresses or ageing mechanisms:

- Definition how long a particular product function would endure, after preparing and/or using the product under recommended operational conditions (drop/shock resistance, ingress protection, abrasion, biotic resistance, abiotic resistance, water resistance/permeability)

(European Commission, 2023)

EXTENDED USE PHASE

The EXTENDED USE PHASE is the phase in which measures to extend the lifespan of the product beyond the initial life cycle are implemented. The following fields of action are intended to extend the product‘s life cycle, encouraging consumers to utilise the product for a more protracted period rather than purchasing a new one. It is important to strike a balance between design interventions and minimal additional environmental impact. The fields of action that are pertinent to the extended us phase are DESIGN FOR REPAIR OPTIONS, FOR UPGRADABILITY and FOR MODULARITY.

15 DESIGN FOR REPAIR OPTIONS

In order to extend the lifespan of a product, it is essential that the product is designed with ease of repair in mind. The repairability of a product must be considered at the design stage, with the objective of ensuring that individual components are readily replaceable or that the repair technique can enhance or preserve the design of the product. (Bakker et al., 2014, p. 97; Shedroff, 2009, p. 289 ff)

Practical Application: The dissemination of repair options can be facilitated through tutorials or workshops, empowering users to undertake repairs independently. An alternative option would be for the company or partner company to offer them as a service. Online tutorials, in-store events or company-owned repair services can be used as communication channels for visible (visual mending) or invisible (technical/functional) repairs. Furthermore, QR codes on product labels provide users with the option to access the company‘s website or social media platforms. These provide information on the correct care for the products, as well as on repair and refurbishment options, based on their recyclability (e.g. re-dying, replacement of individual parts). Repair kits, which are available for purchase and customised to align with the product range, are designated as ‚repair accessories‘. These kits contain patches and/or add-ons, for example, to repair and/or conceal defective areas. In contradistinction to the processes of reuse and remanufacturing, the decision to repair is determined by the customer. Henceforth, evidence of any repair measures implemented should be incorporated into the digital product passport.

A technical-functional repair is characterised by a manufacturing process of high quality, with components that are capable of being removed or replaced, and the absence of processes such as gluing (e.g. lining, glued elements). Moreover, buttons are more readily reparable than zips, due to the fact that they are more easily replaceable.

The following decisions could support this field of action:

- Communicate information on repair options and services to customers
- Develop guidelines to ensure the product‘s repairability and communicate them in a standardized format to external repair partners and retailers
- Support repairability through standardized components, replacement parts, and repair kits
- Provide DIY instructions, visible mending strategies, organize DIY workshops and community events in collaboration with marketing and design teams to strengthen customer loyalty, brand identity, and knowhow about repair

16 DESIGN FOR UPGRADABILITY

The possibility of upgrading the product is considered in DESIGN. This upgrade option can be irreversible or reversible. Upgrading increases the value of the already existing product and thus extends the use phase. (Bakker et al., 2014, p. 101; Fontell & Heikkilä, 2017)

Practical Application: Upgradability is achieved by upgrading the product (aesthetically or functionally) as provided for in the initial design. The ‘Upgradability’ field of action offers both users and brands a great deal of design freedom. The aim is to renew the value of a product in order to extend its lifespan. In the ‘Upgradability’ field of action, the product or sub-product remains in the possession of the customer. The added value comes from the fact that the customers carry out the upgrade themselves, giving the product/sub-product a new function, a new application, a reuse and emotional added value. A leverage effect is achieved through the creation of brand-driven trends in the form of supported DIY. Brands can be a driving force by providing inspiration, upgrade kits, tutorials or workshops. For example upgrading can be achieved through dyeing, tie-dye and printing processes. It is also helpful, to develop custom dyeing and printing recipes. Furthermore, simple pattern changes or functional changes of products are shared, such as suggestions for alterations or repurposing, including the necessary patterns (shortening, tightening, creating new products e.g. Furoshiki, etc.)
The following decisions could support this field of action:

- Develop design and product upgrade guides in collaboration with design and marketing teams
- Implement upgradability in marketing campaigns.
- Provide tutorials, tools and upgrade kits at the point of sale to the costumers (digital and in-store)
- Communicate do’s and don’t’ s from the perspective of recycling (e.g. no glues, no hard parts etc.)
- Actively involve customers in upgrade and repair processes through workshops, events, and local partnerships

17 DESIGN FOR MODULARITY

The modularity of a product enables customers to adapt a product to their own needs after purchase but also beyond its useful life. This can be either a functional modularity or aesthetic modularity. Modularity requires the compatibility of the individual parts and thus also enables better repairability. (Bakker et al., 2014, p. 93 ff)

Practical Application: The 'Modularity' field of action offers a significant degree of creative freedom for DESIGN. The objective is to address the diverse and evolving needs of a product in order to ensure its emotional sustainability. The design motto is to mix and match materials, trims and colours. Starting from a basic product, however, the focus is on connectable sub-products that can be added playfully or in response to new needs or understood as a product extension. The physical compatibility and ease of assembly of all sub-products must already be included in the initial design. This design practice is based on a selected, consistent range of materials, trims and colours. There is not ONE product, but variably combinable, connectable sub-products from which a product can be formed, combined and designed. Customers have the option of changing the product and adapting it to changing needs. Modular sub-products can be both functional and aesthetic (collars, hoods, extra pockets, inner lining, etc.).
The following decisions could support this field of action:

- Prefer the use of production waste (such as offcuts) from high-quality materials to develop modular, interchangeable, detachable and customizable product components that enable additional use cycles
- Develop colour and material schemes that span multiple collections to ensure that products and sub-products can be mixed and matched over a long usage period
- Ensure early coordination between design, marketing, and sustainability teams within the product development process to support the implementation of modular and circular product strategies and to enhance customer engagement
- Maintain close communication with customers to understand their needs regarding sub-products in order to support emotional sustainability

CHECK WITH ESPR DRAFT
REQUIREMENTS EXTENDED USE PHASE

Introduction of a repairability scoring index/label:

- Identification of priority parts
- Identification of relevant parameters influencing reparability
- Scoring system and aggregation

Availability of repair (+upgrade) information and maintenance instructions to operators and/or end-users:

- Disassembly map or exploded view
- List of necessary repair and test equipment
- Technical manual of instructions for repair
- Diagnostic fault and error information
- Component and diagnosis information
- How to access professional repair (internet webpages, addresses, contact details)

Spare part (and software update) availability and delivery time:

- Spare part list
- Duration: spare parts for a minimum period from (X) month after the date of placement on the market until (Y) years after the date of end of placement on the market
- Method of availability: procedure for ordering spare parts shall be available on the free access website of the manufacturer, importer or authorised representative for the full duration
- Delivery time: manufacturers, importers or authorised representatives shall ensure the delivery of the spare parts within (X) working days after having received the order
- Maximum price: manufacturers, importers or authorised representatives shall indicate an expected maximum pre-tax price at least for spare parts (either in Euro or as % indicative purchasing price of the product)

Use of standard components:

- Use of standardised components to secure interchangeability

Modularity; transformability; detachable/adjustable elements:

- Modular design (the product is built from individually distinct functional units), transformability, detachable elements; adju table sizing, customizable surfaces, changing fabric

(European Commission, 2023)

RE-USE PHASE

In the RE-USE PHASE, measures are implemented to extend the life of the product beyond the first or second life cycle. The following fields of action are intended to give the product or its sub-products a new phase in its life, encouraging consumers to use the product for a longer period rather than purchasing a new one. A balance must be made between design interventions and minimal additional environmental impact. The fields of action here are DESIGN FOR REMANUFACTURING and FOR REUSE.

18 DESIGN FOR REMANUFACTURING

Resource-efficient product components or semi-finished products are reused before they are broken down into their raw materials and returned to their material flows. For this purpose, the quality of the material and the type of connections of individual parts must be taken into account. A corresponding design can also favour remanufacturing by making future remanufacturing processes less time-consuming. (Bakker et al., 2014, p. 105 ff; MacArthur, 2017; Fontell & Heikkilä, 2017; RSA, 2016)

Practical Application: Remanufacturing focuses on the industrial reuse of products and sub-products. The aim is to think of product components in DESIGN as raw materials for remanufactured products. Remanufactured products are already planned in the initial design so that subsequent industrial reprocessing is possible. The requirement for this is a catalogue of pattern pieces that allow for maximum possible combinations and repeated material use. This results in a product variance. The design process is strategically laid out over several lifecycle phases and includes, for example, a multi-year colour and material concept, the connectivity and reusability of accessories and the ability to combine used products and new sub-products. From a design perspective, the ability to combine old and new is of central importance. Where possible, remanufacturing is a cascading process from 'large' to 'small'.
End customers must be informed about the lifecycle phases of a product and return logistics must be set up so that the products can be returned for remanufacturing. Exciting incentives and reward systems need to be developed. If remanufacturing is not yet planned in the initial design, remnants, leftover stock and used clothing are also suitable, which can be repurposed by DESIGN and resold as standard parts, small series or unique pieces.
The following decisions could support this field of action:

- Incorporate remanufacturing at the design stage by integrating design options, standardized components, a multi-year colour and material concept and high-quality materials suitable for remanufacturing (e.g. heavy weight 100 % bio cotton fabric)

- Establish a take back system regarding remanufacturing including pre-sorting training for in-store employees
- Build a remanufacturing partner network preferred with local remanufacturing companies and social projects
- Strengthen remanufacturing as a brand strategy through targeted communication and the systematic remanufacturing of unsold and returned items, as well as leftover and off-cut fabrics

19 DESIGN FOR REUSE

The most effective recycling of a product that is no longer needed by the first user is its reuse. A product is designed to be reused for as long and as often as possible by different people. This is inherent in the product through various design strategies (e.g. one-size, timeless looks) and is reflected in the material quality and workmanship. (Fletcher 2004; Fontell & Heikkilä, 2017; MacArthur, 2017; RSA 2016)

Practical Application: On the one hand, one-size products and products with a timeless design are suitable for reuse, as they are more likely to be resold. This means that one size fits more people than XS, or that a simple design appeals to both people with distinctive taste and people who do not want to stand out. On the other hand, products that have collector's value are also suitable for reuse because, for example, they originate from a certain era or are designed by sought-after designers and have a certain style.
The curation of reused products is also part of this field of action and relies on products ageing well and retaining their quality. For this reason, the future ageing of the products is taken into account in the initial design and care is taken to ensure that used and new products work together. This makes it possible to curate old and new so that first-hand and second-hand products can both exist on the sales floor at the same time and thus encourage resale.
From the perspective of the brand, consideration should be given to using different reuse channels: reuse at one's own point of sale and in one's own online shop or via partnerships with online platforms – with the effect of the brand being limited in the last two channels.
The following decisions could support this field of action:

- Incorporate high-quality materials, adjustable fits, and timeless styles into the design strategy to ensure long-lasting use by multiple owners
- Define criteria for in-store reuse and communicate them to store staff for pre-sorting
- Communicate different reuse options to customers
- Establish partnerships with external local reuse providers and reverse logistic partners

CHECK WITH ESPR DRAFT **REQUIREMENTS RE-USE PHASE**

Disassembly generally or related to Tools, fasteners, Working Environment and Skill Level:

- Manufacturers shall ensure that joining, fastening or sealing techniques do not prevent the disassembly for repair or reuse purposes
- Fasteners shall be removable or reusable
- Tools: the process of replacement shall be feasible with no tool, a tool or set of tools that is supplied with the product or spare part, or basic tools, or with commercially available tools
- Working environment: the process of replacement shall, as a minimum, be able to be carried out in a workshop environment or use environment
- Skill level: the process for replacement shall, as a minimum, be able to be carried out by Expert or layman or generalist

Use of component and material coding standards for the identification of components and materials

(European Commission, 2023)

RECYCLING PHASE

In the RECYCLING PHASE, the material is recovered in a closed loop where possible in order to reduce virgin resource consumption for textile products. It is important to note that recycling should be the last option for utilising the textile product after all previous cascades have been exhausted. The fields of action in this phase are DESIGN FOR RECYCLING AND RECOVERY, FOR MONOMATERIALITY, FOR MATERIAL SORTING & SEPARATION, FOR RECOVERED FEEDSTOCK, FOR MECHANICAL, THERMAL, CHEMICAL RECYCLING and FOR BIODEGRADEABILITY.

20 DESIGN FOR RECYCLING AND RECOVERY

From a design perspective, the material selection, combination, construction, trims and finishing in a textile product define the end-of-life recovery pathway. The hierarchy of cascades within the circular economy should be considered (Use > Extended Use > Reuse > Remanufacturing > Recycling/Recovery).

Essentially, there are four different options for end-of-life products: return to the biological cycle, recycling in the technical cycle, thermal recovery or disposal. In thermal recovery and disposal, the value of the material is irretrievably lost, this must be avoided. Products that are returned to the biological cycle must be fully degradable (McDonough & Braungart, 2010, p. 92 ff). The time required for these materials to decompose must be taken into account. Material groups of products that are designed in such a way that they can be returned to the industrial metabolism from which they originate can enter the technical cycle (McDonough & Braungart, 2010, p.109 – 115). There are different methods for reprocessing materials in the technical cycle through recycling (mainly chemical, thermal and mechanical processes). The use of materials in a technical cycle is managed through stock management. Materials in this cycle are partially non-renewable resources and must therefore be used with care.
In particular, separation into technical and biological cycles must be ensured at the end of life by taking this into account in product development.
(Balkenende & Bakker, 2018 b, p. 77 ff; Haffmans et al., 2018; Karell & Niinimäki, 2019; MacArthur, 2017; Niinimäki & Hassi, 2011; Tyler & Han, 2019)
The following decisions could support this field of action:

- Adapt product requirements to suit recycled quality (e.g. using recycled fibres in jeans rather than shirts)
- Integrate recycling requierements into product development
- Provide recycling requirements to suppliers and manufacturers
- Establish take-back and recycling programs through reverse logistics services, incentives, the use of QR codes, pictograms, and DPP-compliant product information to ensure transparent communication

21 DESIGN FOR MONOMATERIALITY

If products consist of only one material, sorting is simplified and, ideally, the product can be returned directly to the material cycle. The aspect of monomateriality or material purity must be taken into account, in particular for products that are processed in the technical cycle. (Hornbogen et al., 2019; MacArthur, 2017; Textile Exchange, 2020)

Practical Application: The DESIGN FOR MONOMATERIALITY field of action aims to use only one material for all components in products. This supports the return of materials into a closed cycle and minimises the negative effects of material complexity at the end of the life cycle. Composite materials can also be used as long as they can be returned to the cycle without separation. Monomaterials can therefore also include material strategies that include material blends such as polycotton if there is an appropriate recycling process available. The decisive criterion is the compatibility of all processes, such as the addition of additives, dyes and finishes used, but also repairs, with the requirements of a functioning material cycle.
In practice, this means that ideally all materials of a product, such as sewing threads, labels, zippers, rivets, buttons, sequins, embroidery, etc., are made of the same material, take-back is ensured, the products are returned and all materials are compatible with the respective recycling process.
The following decisions could support this field of action:

- Promote the use of monomaterials throughout the entire product, e.g. for fabrics, yarns, trims, labels and accessories
- Check requirements of specific recycling technologies (e.g. possible tolerances within monomaterials or disruptors such as solid parts)
- Declare material composition beyond legally required declaration standards

22 DESIGN FOR MATERIAL SORTING & SEPARATION

The separation of different materials is included in the design of the product through appropriate separability according to material qualities. The purity of the individual materials must be taken into account, as well as the type of material combinations in products.
In some cases, technologies are being developed that can chemically separate polycotton blends, for example, and thus recover both raw materials (Rex et al., 2019; Sandin et al., 2019; Textile Exchange, 2020, p. 56 and p. 80), but this additional step must also be taken into account in the life cycle assessment of products. Built-in separability within the product allows materials to be returned to different biological and technical material cycles later. If processing solutions do not yet exist for certain materials, separability of the materials in the product must still be ensured. (Braungart, 2012; McDonough & Braungart, 2010, p. 103 – 105; Karell & Niinimäki, 2019)

Practical Application:
Material sortability: Textile blends occur at different stages of production: at the fibre level, at the yarn level, during fabric formation and in manufacturing and reuse of the product. Blended fibre strategies can only be pursued if the

material specifications for a fibre-to-fibre recycling technology are adhered to. For example depending on the recycling technology, tolerances of a percentage of elastane can be used. Further, avoidance strategies for elastane can be implemented at the pattern or material level (e.g. loose cuts, mechanical stretch achieved through woven or knitted structures). If elastane cannot be avoided, biodegradable elastane can be used.

Material separation: During pre-sorting, non-textile parts are separated from textile parts for the cutting and shredding process. This requires a pre-processing step. Embellishments (e.g. prints, embroidery, rivets, buttons) should be applied sparingly and in clusters. Labels should be sewn together and easily removable or alternatively printed on. Adhesives should be avoided as far as possible.

Colour separability: A sorting strategy for colours is particularly important in mechanical recycling to avoid further finishing steps. Finishing processes must be chosen that meet the requirements of recycling technology. Sorting can be enhanced by AI-based systems.

The following decisions could support this field of action:

- Design products so that components, trims, rivets, buttons and other hard parts are detachable or strategically clustered to enable easy removal before recycling
- Minimize material complexity in products to support material separation
- Ensure that different materials within a product are clearly distinguishable by means of colours, textures, or other visual markers
- For mechanical recycling processes, adopt monochrome or low-contrast colour schemes to facilitate effective colour separation
- Include disassembly-friendly solutions (e.g. reusable screw-on jeans buttons, removable or embroidered rivets, threads that dissolve with heat) into design and development processes at an early stage to facilitate material separation
- Avoid material blends composed of different fibre types, as these are generally difficult or impossible to separate during recycling processes (e.g. avoid elastane; achieve stretch through mechanical solutions instead)
- Communicate the recycling technology the product is designed for to support sorting and material separation, for example through a digital product passport

23 DESIGN FOR RECOVERED FEEDSTOCK

The ‘Recovered Feedstock’ field of action focuses on technical or biological cycles. The technical cycle aims to reuse the material of products by means of mechanical, thermal or chemical treatment. When using the materials in a technical cycle, the aim is to achieve the highest possible quality of use and the highest possible degree of utilisation. Materials should only be combined in a conglomerate if it can be returned to a material cycle without the need for separation into different materials (e.g. polycotton can be reprocessed as a blend). (MacArthur, 2017; Lacy & Rutqvist, p. 119, 2016)

The use of biodegradable raw materials essentially enables products to be returned to the biological cycle. As a result, their disposal does not place a burden on the environment. (McDonough & Braungart, 2010).

24 DESIGN FOR MECHANICAL RECYCLING

Mechanical recycling is a physical process that can be used for textile or fibre recycling or as pre-processing for thermal or chemical recycling (Stubbe et al, 2024). Textile surfaces are mechanically broken down and fibres are recovered. The process is resource-efficient in terms of water, energy and chemical consumption.

Mechanical recycling preserves the fibre structure, so natural fibres can be recycled as such. Traditional mechanical recycling reduces the fibre length and thus the quality of the secondary raw material. Optimisation of fibre lengths can be achieved with new gentle processes (soft mechanical recycling).
Fibre blends can generally be processed with this technology. Elastane and certain coatings are problematic. Sorting by colour helps to minimise the need for re-dyeing or avoid it altogether. This allows for further savings in resources.

Practical Application: Today mechanical recycling is mainly done for post-industrial cotton-rich waste and for wool and wool-like fibres. Careful sorting forms the basis for a high-quality input material for the mechanical recycling process. The process is compatible with different ranges of fibre compositions, it tolerates impurities, and is particularly well suited to protein-based fibres (e.g. wool, cashmere, etc.)

Pre-processing: For mechanical recycling, sorting is done by material quality and often by textile structure (woven/ knitted/warp-knitted) as well as by colours. Depending on the desired quality outcome, disruptors (labels, buttons, zipper, etc.) must be removed. In the industrial pre-recycling process, the entire product is first cut into small squares. Any contaminated squares, unsuitable for recycling (printed, embroidered or finished otherwise), are sorted out and not recycled. Particularly in the case of goods that are subject to disruptor removal, it makes sense to assess how manual or automated removal of disruptors can be supported.

Further requirements: In general, also seams are considered to be disruptors. Therefore, seams must often be removed manually. Seams must be made of the same material and in the same colour as the product to be recycled. Coatings should be avoided. Elastane is not recyclable but can be tolerated to a certain extent.

If a product is to be finished, a local print/embroidery/metal trim is preferred over an all-over print/embroidery/ patch/metal trim.

Secondary fibres: With gentle mechanical recycling, a fibre shortening of 10–20 % is to be expected. Short fibre waste can be controlled depending on the downstream process and ranges between 5–10 %. In addition, material loss is influenced by the fabric weight and the density. During spinning, depending on the quality of the recycled fibres, a corresponding proportion of virgin fibres or recycled fibres from pre-consumer waste is blended in (Adler et al., 2024). This improves the quality of recycled yarn.

The following decisions could support this field of action:

- Limit the elastane content to a maximum of 5 % and systematically use sewing, and manufacturing techniques that are suitable for recycling
- Avoid using prints and create your designs as mono-coloured products. Avoid coatings
- Continuously research, test, and coordinate recycling requirements, material qualities, and recycling guidelines in collaboration with recyclers, research institutions, associations, and specialized suppliers.
- Further support the development of recycling technologies through pilot projects, joint ventures and the exchange of education and knowledge, and establish suitable recycling partnerships

25 DESIGN FOR THERMOMECHANICAL RECYCLING

Thermomechanical recycling melts down thermoplastic polymers such as PET, PA6, PP PA6,6, PLA. It is a cost-effective, efficient and well-established process, but its application in textile-to-textile recycling remains limited. Limitations of the technology are viscosity problems for PET (polymer degradation) and high feedstock purity requirements (more than 99 % single or compatible polymers required). Even small amounts of cellulosic material or elastane as well as small amounts of foreign materials in textiles that are introduced to the textiles via finishes, flame retardants, dyes or prints, as well as different types of polyester, interfere with the process (Accelerating Circularity, 2024; Duhoux et al., 2021; El Darai et al., 2024; Fashion for Good, 2022). The technology is mainly used for recycling production waste that has been collected separately.
The quality of the secondary raw material is inferior compared to virgin fibres. With a high purity of the feedstock, a good quality of the secondary raw material is possible. (European Commission. Directorate General for Internal Market, Industry, Entrepreneurship and SMEs, 2021)

Practical Application: The preferred material input is 100 % post-industrial polyester, while post-consumer polyester is currently considered an unsuitable material. Blends should be avoided. The input material must be sufficiently pure. Blending different coloured materials can lead to undesirable colours, as dyes and pigments remain in the secondary material, and the colour can also

change during the process. In addition, impurities remaining in the secondary material may violate the REACH regulation. Furthermore, the material qualities achieved in thermomechanical recycling are usually not sufficient for the spinning process. Therefore, the secondary materials usually need to be blended with high proportions of virgin materials.
The following decisions could support this field of action:

- Use monomaterials and avoid as many additives, dyes and coatings as possible
- Take the recycler’s material requirements (e.g. purity, fibre type, finishes and colours) into account at the design stage so as not to adversely affect the recycling process

26 DESIGN FOR CHEMICAL RECYCLING

Chemical technologies are better suited for the treatment of textile material blends, as the recycled material can be purified and separated to obtain a pure, colourless secondary material approaching virgin material quality. These technologies require more energy and water and must be scaled up to ensure economic viability. In addition, sorted and disassembled or separated input is required (Stubbe et al, 2024). Cellulose fibres, such as cotton, can be chemically recycled via a pulping process in which the cellulose is suspended in a liquid that can then be spun into MMCF (man-made cellulosic fibres); in blends, only the cotton content is recovered (Stubbe et al, 2024). Synthetic and blended textiles can be recycled by solvent-based dissolution, hydrothermal processes or enzymatic processes. None of these processes has reached the commercial stage. Monomer recycling of synthetic textiles is being researched for PET waste, while it is already in commercial use for PA6.

Practical Application: Compared to other recycling technologies, chemical recycling is less developed, and its environmental impact as well as the deployment on a commercial scale is uncertain.

Cotton: In cellulose recycling, the preferred material input is 100 % cotton. Applied pigments and coatings must be critically evaluated as they can disrupt the process. It should be noted that the structure of the cotton fibre is not preserved and that a natural fibre becomes a synthetic fibre.

Polyester: Preferred input materials are polyester rich: Emerging polyester recycling technologies can process three main categories of fibre input: either pure PET, >70 % PET or PET/cotton blends (Accelerating Circularity, 2024). A fraction of the polycotton may be lost, depending on the process. In other processes, polyester can be processed and cotton further processed into a man-made cellulosic fibre (e.g. viscose, lyocell) (Worn Again Technologies, 2024).

Pre-processing: The sorting accuracy using NIR technology (NIR: near infrared) decreases once blended materials consist of more than three types of fibres. Trims and embellishments should be avoided, if possible, as they must be removed before recycling.

The following decisions could support this field of action:

- Take into account the criteria of different chemical recycling providers as a part of the initial design and material strategy

27 DESIGN FOR BIODEGRADABILITY

The use of bio-degradable materials and additives implies the possibility of biodegradability of the respective products. Their disposal does not present a significant burden to the environment, and their components can also be returned to the biological cycle.
The renewal and/or regrowth/degradation rate must be considered in relation to the resource extraction. Different approaches can be considered here:
Sustainably grown, renewable raw materials, such as sustainably managed forests.
Biodegradable production waste, such as straw from agriculture, or biodegradable cutting waste from the textile industry.
Material that is currently considered a waste product, such as coffee grounds, fruit peels or used textiles made from pure animal or plant fibres as well as pure degradable organic-cellulosic synthetic fibres.
(Haffmans et al., 2018; McDonough & Braungart, 2010, p. 105 – 109)

Practical Application: No industrialised process is yet available for biodegrading large quantities of textile products. The DESIGN FOR BIODEGRADABILITY field of action states that if a textile product is made of biodegradable materials, nature uses the product as a nutrient. In design practice, it should be noted that biomaterials such as organic cotton, linen or even hemp processed into textiles are no longer pure materials. They are treated with foreign substances, dyed, bleached, finished, etc. In addition, finished products often contain other contaminants, such as sewing threads, inserts and fasteners, which must be removed just as they are in the technical cycle. It should also be noted that the denser a textile structure (e.g. a textile woven with a high pick density) or the more multi-layered (double lapped seam for denim products), the longer it takes to degrade.
The following decisions could support this field of action:

- Check and optimise the renewal and/or regrowth/degradation rate in relation to the resource extraction
- Make sure all components and additives involved can be returned to a biological cycle, or ensure that components can be easily removed to be recycled in the technical cycle
- Provide your customers with clear information about the benefits of biodegradable textile products and their limitations

CHECK WITH ESPR DRAFT **REQUIREMENTS RECYCLING PHASE**

Ability to easily separate the product in different materials:

- Avoiding connections that enclose a material permanently (such as inserts into plastic)

Condition for the access to product data relevant for the recycling, including dismantling information:

- Marking of parts and materials, use of component and material coding standards for the identification of components and materials, access to information, hardware and software needed for the recycling process
- Making available, on a free-access website, the dismantling information needed to access any of the product components; this dismantling information shall include the sequence of dismantling steps, tools or technologies needed to access the targeted components
- Providing information on the indicative weight range at component level of specific CRMs and environmentally relevant materials

Recyclability information to consumers / recyclability claims:

- Including a sentence or a pictogram in relation to product disposal
- Providing guidance to consumers about product dismantling (if necessary before the recycling)
- Providing information on the recyclability of the product Introduction of a recyclability scoring index/label
- Provision on minimum content of post-consumer recycled material expressed either as a fraction of the total material input (in %) or in absolute numbers:
- Average minimum recycled content for a certain product group
- A mass balance content at factory level
- Define material origin (pre- or postconsumer waste)

(European Commission, 2023)

END OF LIFE PHASE

In the END OF LIFE PHASE, the material has reached the end of its life cycle and measures to extend its life are no longer possible.

28 DESIGN FOR LANDFILL OR INCINERATION

If material cannot be returned to either the biological or technical cycle, it may still be used for energy production by thermal recovery. This should be done in an incineration plant with flue gas purification and where thermal energy is used for thermal networks or heating. Landfilling should be avoided due to harmful environmental impact.

REVERSE LOGISTIC CHECKLIST

This checklist facilitates the translation of circular ambitions into operational practice. It is grounded in expert interviews and a review of the relevant literature, and is structured along seven process steps spanning from the point of sale to the end-of-life phase of a product (downstream perspective). For each step, exemplary, practice-oriented measures for the implementation of a reverse logistics system in support of circularity are identified. The compilation does not claim to be exhaustive.
This document can be employed both as an analytical tool to assess a company's current state and as a guiding framework for the implementation of reverse logistics. Fulfilment of all checkpoint is not required; the checklist is intended to provide orientation rather than to impose rigid requirements. For each measure, roles and responsibilities across Design, Brand, Consumer and Resource Management are explicitly defined, thereby enhancing transparency and accountability among all relevant stakeholders. Developed and empirically tested in collaboration with stakeholders across the value chain, this tool provides concrete, practice-oriented measures to support the development and operation of an effective reverse logistics system.

Design & Production

Design
Designers are able to develop circular products and respective guidelines based on the CUT design guide. They are skilled at supporting stakeholders along the value chain with regard to circular design decisions.

DESIGN & PRODUCTION

Sale

Brand
Brand is capable of developing a sustainable corporate strategy that measurably integrates the principles of the circular economy into the business. It is also capable to plan, implement, and effectively communicate circular design strategies and concrete implementation concepts to its customers.

POINT OF SALE

- Equipe the PoS online or in store to deliver key information about the product live extending measurements and the product return process.
- Train your customer advisors in topics related to the circular economy to enable them to communicate with customers about circular products.
- Allow your data to circulate with the product throught the downstream processes using labels or other trackers
- Set up specific communication materials (physical or digital) that explain how to care for and repair your products and refer to partners.
- Set up the infrastructure required to store your product data in accordance with EU regulations on the DPP.
- Use media channels to provide your customers with specific information on where, when and how to return their product.
- Provide your costumer with the most important product information, such as:
  - Material composition
  - Product journey (incl. Recycling)
  - Key manufacturing processes
  - Environmental impact
- Incentivize your costumers to repair and return their products.

Use / Care

USE-PHASE

- Define a product lifespan based on product and material quality.
- Clearly communicate the product lifespan to customers via existing media channels and PoS staff.
- Define and communicate the typical washing frequency, and provide specific care instructions for prolonging the life of the garment.

Consumers & Users
Customers have knowledge about how they can explore and fulfill their role as prosumers within circularity, on the one hand by extending the lifespan of their products, and on the other hand by acting as material suppliers when returning their products.

Repair / Upgrade

EXTENDED USE-PHASE

- Identify the main degradation drivers and the top failure modes for your product and provide repair options accordingly.
- Identify key repair/upgrading partners fitting to your market/products and location and start collaborating.
- Create a clear repair pricing list and publicise it through your media channels.
- Communicate your repair partners on your normal media channels and at the point of Sale.
- Make spare parts accessible and standardized, even deliver them with the product.
- Identify key upgrading partners that fit your market, products and location, and start collaborating with them.
- Set up the necessary infrastructure, either online or in-store, to enable customers to easily return products for repair.
- Use media channels to inform your customers about your partnerships with companies that handle product upgrades.
- Provide the knowledge, tools, materials and inspiration needed to upgrade products in-store and online via your media channels.

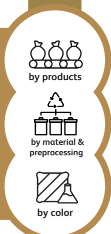
POINT OF RETURN

- Set up the infrastructure for product return according to your touchpoints:
  - Add collection stations and bins in store
  - Add a mail-back option for the online store
- Define who is responsible for managing product returns in-store and online.
- Define a clear customer journey for the product returns process.
- Incentivize the return of used products after a long use time.
- Implement a presorting step to improve the quality of returned goods.
- Educate customer-facing personnel (sales, marketing, etc.) about the product tack-back process regularly.
- Set up a system to track the reasons for product returns and use this information to improve product quality throughout the product's lifetime.
- Set up a system to track basic data on return quantities and types of products.
- Define and communicate clear criteria for products, materials and colours that can be returned and therefore circulate in the circular economy, in line with the needs of the downstream partners.

TRANSPORT / COLLECTION

- Identify the location of the most suitable recycling and sorting facilities for your product types and region.
- Define storage capacity and collection cycles, and ensure that these are coordinated.
- Make sure you meet the minimum volume requirements of your downstream partners.
- Use the existing logistic network as best as possible.
- Ensure that the agreed quantities are ready at the collection points in good time.
- Define the safety regulations for the goods to be transported and communicate these to the logistics service provider.
- Set the collection rates and review the costs regularly (every six months).
- Arrange collection quantities, collection points and collection times with your logistics provider.

Ressource MGMT
Resource management has in-depth knowledge of circular design and material strategies, including the production of secondary raw materials, in order to specify recycling requirements for actors in the value chain (upstream and downstream) accordingly, accompanied by methods for collecting and updating data in relation to traceability and transparency.



SORTING

- Identify key sorting partners fitting to your market, products and location and start collaborating.
- Bulk the material according to the requirements of the existing recycling processes.
- Define sorting categories (product, material, color) in according to targeted sorting process (manual / automated) and targeted loop (reuse / mech. recycling / chem. recycling).

RECYCLING/ END-OF-LIFE

- Define the material requirements for the different recycling pathways and communicate them to the relevant upstream partner.
- Set up a system to track the final material fate (upcycling / linear recycling / downcycling / energy recovery).
- Collect data on the products that are recycled. This data can be used for an LCA calculation.
- Energy recovery and downcycling is explicitly categorized as a last resort, only if recycling is not possible.

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