

CIRCULAR DESIGN KIT

Design strategies for material cyclability and longevity



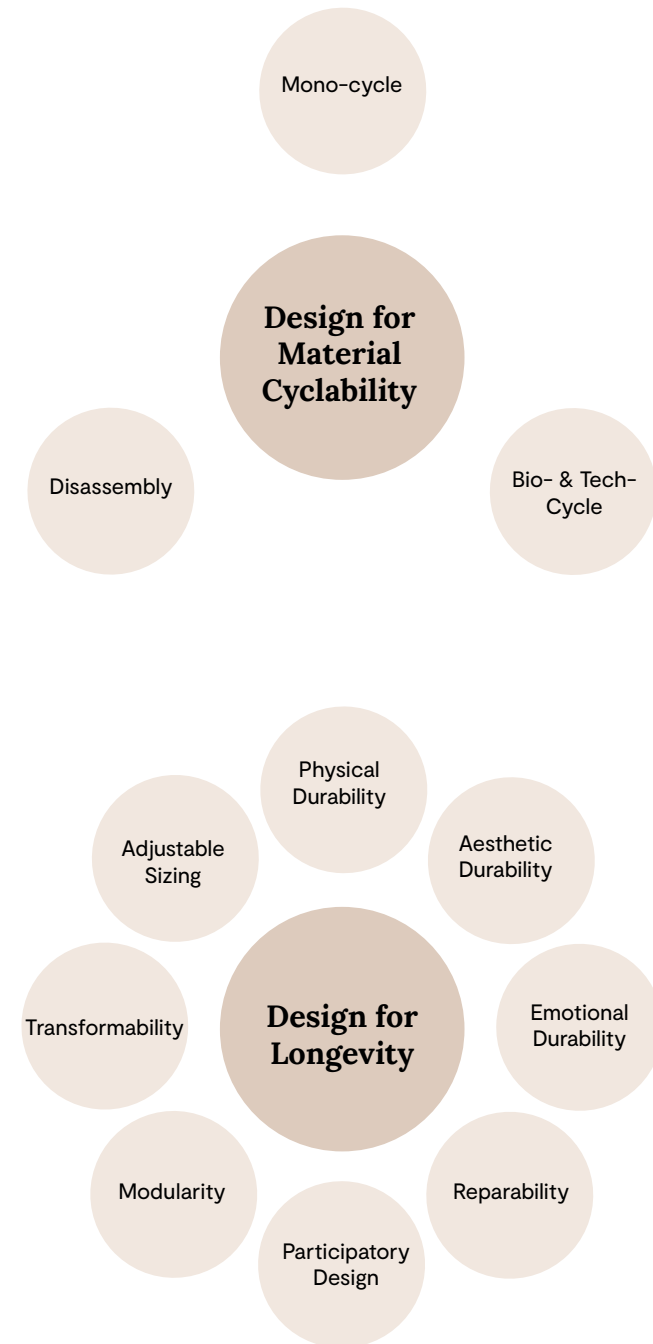
CIRCULAR DESIGN KIT

A circular fashion system relies on thoughtful, clever and responsible design from the very beginning. Designing for circularity is on one hand about considering technical factors such as materials, pattern construction, manufacturing and production processes in order to minimize environmental impact and enable reuse and recycling of products. On the other hand, designing for circularity is about changing behaviours, ideas and common perceptions of what fashion is and can become. Designers have the potential to create products made to last both in function and style, products that capture value over time and promote sustainable use while enabling cyclability. The aim of the circular design kit is to provide you and your team with guidelines and inspiration to explore how circular design can be a driver of creativity and innovation.

Before diving deep into the strategies, activate your thinking by asking yourself a few thought starters:

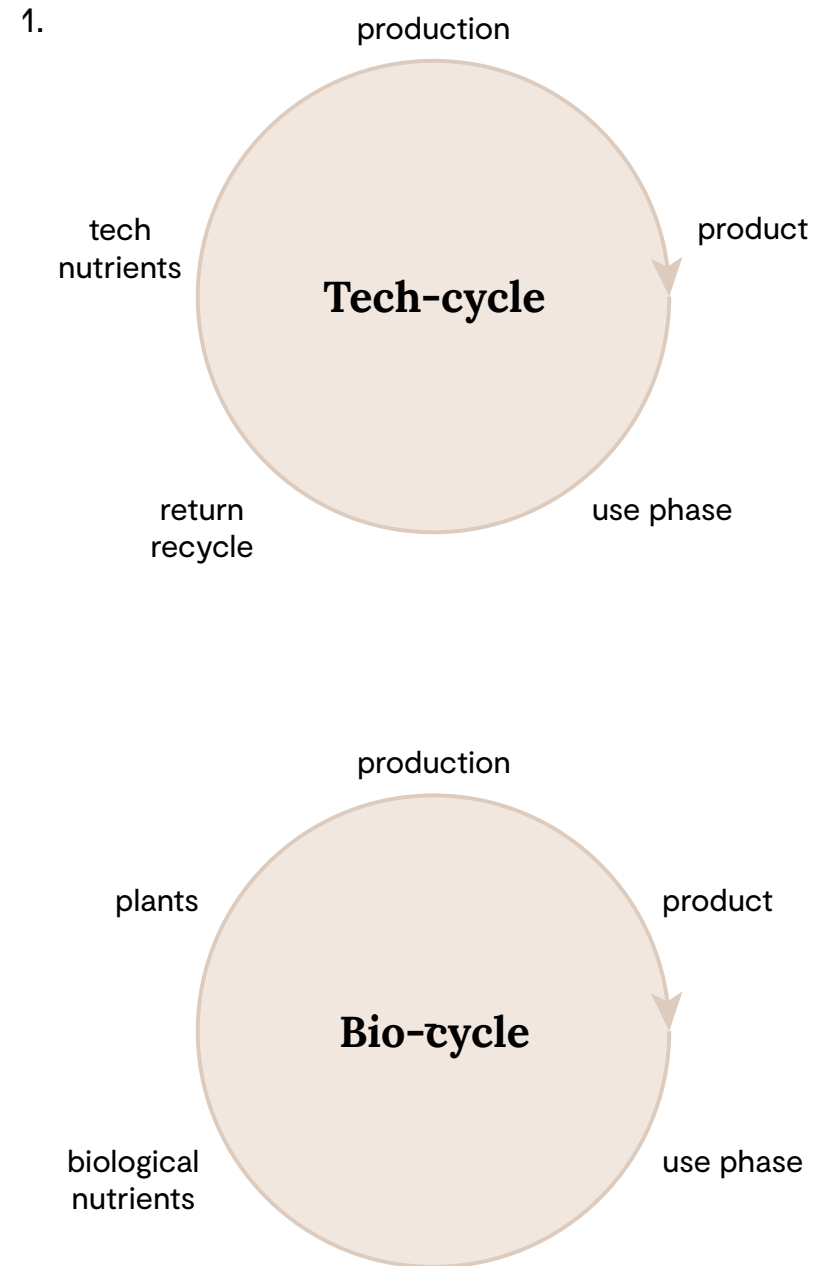
- What is the intended use of the garment? When, how and by whom will it be used?
- How many components does your piece consist of? What will happen with each of these components when no longer in use?
- How can you adjust the design to minimise the use of various components and enable easier recycling?
- How can the piece be designed to increase in value over its lifetime and continue to engage the user?

1.



Tech- & Bio-Cycle

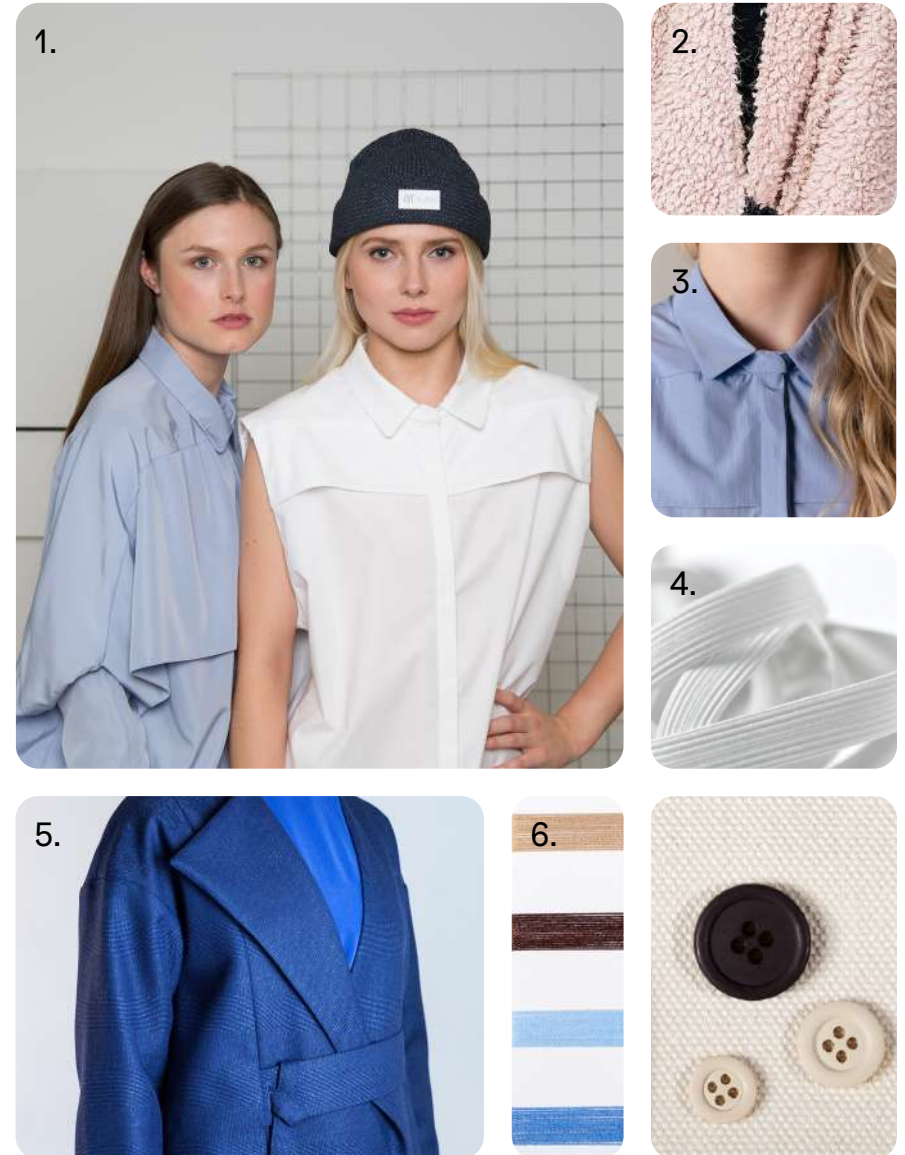
To design for material cyclability one needs to carefully consider how all material components that constitute a product will be effectively used, reused and regenerated in circular systems. Material cyclability aims to eliminate the concept of waste and the need for virgin resources by enabling products to be either recycled in the technical cycle or decomposed and biodegraded in the biological cycle. The tech-cycle refers to materials that have the potential to be either mechanically or chemically recycled and regenerated into technical nutrients for new fibres. These materials can be synthetic fibres made of oil such as polyester, nylon and elastane or natural and man-made fibres like cotton and viscose. The biological cycle refers to organic materials that can degrade or compost in natural or controlled environments under a limited amount of time. Biodegradability refers to the degradation of a material down to base substances with the help of living organisms, while compostability is the capacity of an organic material to be transformed into compost to fertilise the soil. To ensure circularity in either the bio- or tech-cycle, it is necessary that all components of one product, including reinforcements, threads and trims, belong to the same cycle.



1. Graphic visualisation of the technical and biological cycle inspired by the concept of Cradle to Cradle

Mono-Cycle Approach

To design for material cyclability we can take a mono-cycle approach and design products made entirely of materials suitable for the same cycle. This means that all trims and additional, such as buttons, thread, size and care label etc will need to match the main material of the piece and its recycling cycle. In this way, the product is designed to fit within either the biological or technical cycle and therefore to biodegrade or be recycled and regenerated into resources for the future. The most suitable materials for this strategy are versatile natural fibres such as cotton or viscose, or synthetic fibres such as polyester, nylon and biodegradable polymers. A challenge with designing with a mono-cycle approach is the risk of having to compromise with the aesthetic of the product and the quality of its different components. Prints and chemical surface treatments often challenge the quality of the recycling output. Mono-material textile design and surface treatments, like laser engravings and embroidery as embellishment and decoration can be used to ensure material cyclability. If different qualities of materials are needed to reach a targeted function or aesthetic, a piece can be designed for disassembly, meaning that different components are combined in a way that they can be disassembled after use and recycled separately.

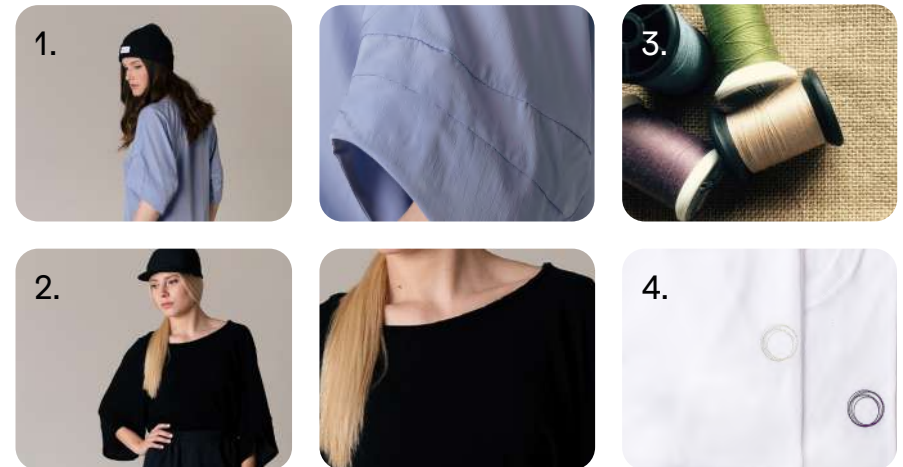
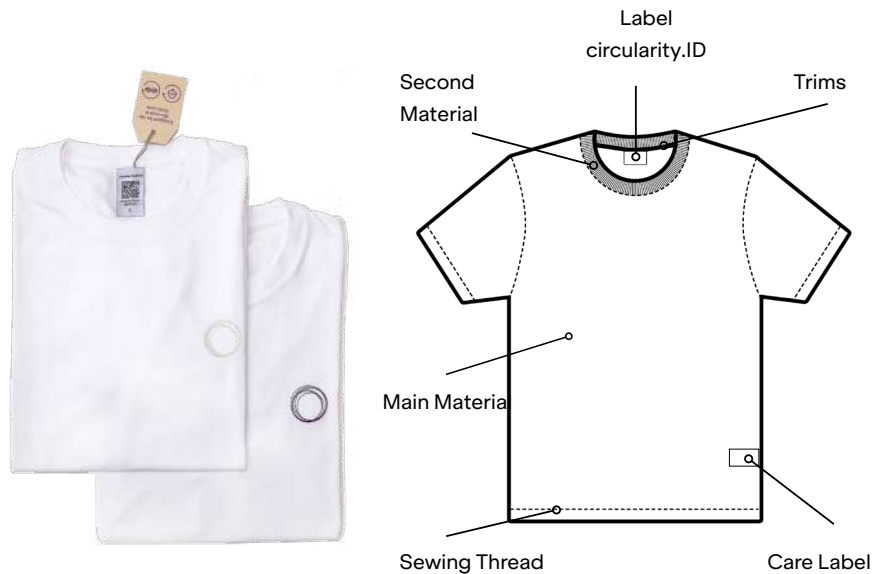


1. Mono-cycle shirt in biodegradable polymer by DfCxJnJ
2. Tactile textile surface in recycled PET by MYRKA studios
3. Collar with triple layer mono material replacing glued interfacing by DfCxJnJ
4. Biodegradable polymer elastic by Lauffenmühle
5. Mono-cycle closing mechanism and lining by Alberte Laursen Rothenborg
6. Biodegradable polymer yarn and buttons by Lauffenmühle

The Circular T-Shirt

Mono-Cycle Approach

By its simple pattern, a T-shirt often consists of only a few components, which makes it suitable for a mono-cycle approach. To design with a mono-cycle approach, main material, trims, labels and thread must all be constituted by one fiber type and consequently be recyclable within the same cycle. A challenge with conventional T-shirts is the presence of elastane, which limits the possibility of recycling. Today's recycling technologies differ regarding the percentage of elastane they can handle. However, in most cases the process of recycling is more efficient and economically viable if this is kept to 2%. If a higher amount of elastane is needed, a biodegradable quality can be used and blended with biodegradable fibres. Another way to achieve stretch is to consider the pattern construction and twist the fabric diagonally when cutting it, following the traditional technique of bias-cut. The t-shirts pictured are made in mono-cycle for either the bio or tech-cycle. All components are carefully selected to fit within one cycle for either chemical polyester recycling, biodegradation or cellulosic recycling.



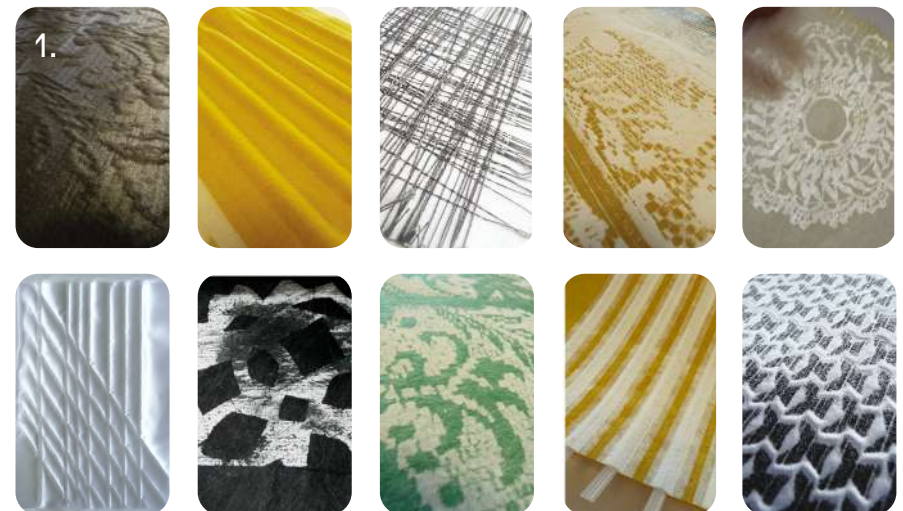
1. rPET textile and sewing thread for chemical polyester recycling by DfCxJnJ
2. Cellulose from regenerated denim and Tencel™ thread by DfCxJnJ
3. Cradle to Cradle gold certified Tencel™ thread by Johann Mueller AG
4. The circular T-shirt optimized for cellulosic recycling by circular.fashion

Recyclable Textile Manipulation

Mono-Cycle Approach

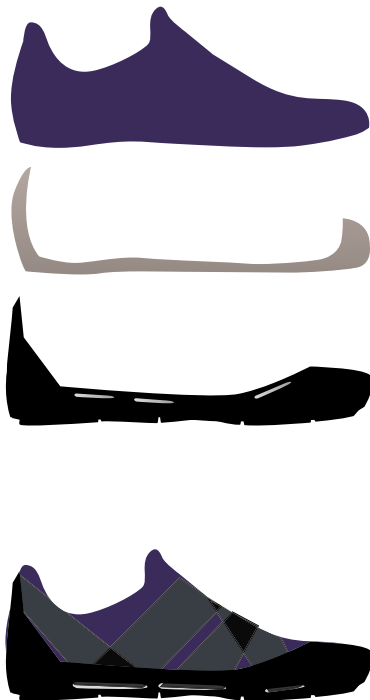


Textile printing is the process of applying colour to a fabric to create various patterns or designs. Today, prints prove to be challenging for recycling processes as they lower the quality of the output because of the synthetic glues, print paste and surface treatments that are applied. There are many strategies for manipulating fabrics and creating decorative textiles without the use of prints. Replacing traditional methods of printing with creative techniques of fabric manipulation would improve the environmental impact during the manufacturing process and increase the likelihood of the garment to be recycled. Fabric manipulation techniques are for example laser engraving and cutting, embroidery playing with thickness of thread and various styles of stitching, weaving to create dynamic movements on the surface as well as pleating and folding techniques or application of external elements onto a textile. These methods can be used on a variety of bio-based and synthetic materials, resulting in varied patterns, colours, textures and functional finishes as shown below.



Modular Recyclable Footwear

Mono-Cycle Approach



Shoes are generally made of many different components which are crucial to the functionality but heavily glued together and therefore difficult to disassemble and recycle. To design shoes for material cyclability, all components need to be made of the same raw material. In the case of shoes this can be challenging as the different components that make up a pair of shoes, such as the sole, inner sock, supportive foam and shell are in need of various textures, elasticities and functions. New technologies such as 3D printing and innovative man-made polymers are expanding the possibilities to create parts of the same material but of different shapes and forms. The prototype pictured, has been designed for modularity and material cyclability using one single raw material adaptable to different functions. The shoe is composed of different parts, an inner sock with reinforced sole with a neoprene touch and a firm and comfortable feeling, a supportive inner sole, a flexible and robust abrasion resistant shell and elastic bands to stabilize the product and comfortably adapt it to the feet. The parts can be mechanically attached to each other, avoiding any use of glue, and ensuring disassembly at end of life.



Design for Disassembly

In order to create endless value for textiles, products need to be designed in a way so that different materials can be recovered separately to be either recycled in the technical cycle or decomposed in the biological cycle. Most products today consist of multiple materials providing either functional or aesthetic meaning and their presence cannot be avoided. Even in cases where garments are made of one main fabric, the closure is often made of another material that needs to be taken apart before recycling. To make the recycling process feasible, clothing containing different materials should be designed for disassembly. This can be done by for example using detachable closing mechanisms, such as cords, buttons, buckles, loops and strips, so that the components of a product at end of life can go into separate recycling streams. Innovative weaving techniques are enabling the production of textiles made of different fibers which can then be easily disassembled for recycling. Design for disassembly encourages to rethink traditional closing mechanisms and assembly methods which can add both aesthetic and functional value. In addition, it benefits reparability as components can be taken off and exchanged, ensuring the longevity of the garment.



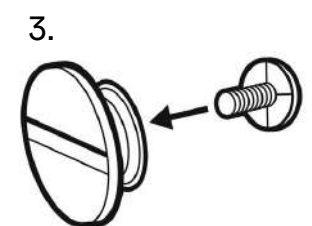
1. Detachable string system and screwable buttons by Alberte Rothenborg
2. Dual-cycle textile separable into two recycling cycles by DfCxJNJ
3. Screwable cufflinks for disassembly of metal parts by Alberte Rothenborg
4. Screwable buttons by Nilorn
5. Closing mechanism for disassembly by Alberte Laursen Rothenborg
6. Detachable metal buttons strip for trousers by Denim Footprint
7. Disassembly swatch design by René Loof

Removable Metal Parts

Design for Disassembly



Traditionally, metal parts like studs, feet, closures and rivets are permanently attached to garments and accessories. As these need to be cut off before recycling, they challenge the process and make it less effective and economically viable. Rethinking the design of these elements and their production methods to be disassembled can enable more effective and time-saving recycling processes. In the traditional mass market design in most of the cases, metal parts are heavily glued and taped, to ensure durability. Therefore, it is recommended to rethink their placement in the product. For example, instead of being hidden inside of the lining, the metal parts can be visible and approachable by both sides, so that they can be repaired or replaced easily and they can come in an additional repair kit for the user. Removable metal parts can also enable the design of seamless products, particularly suitable for post-consumer recycling of materials. The bags pictured showcase how the use of removable metal parts can avoid the use of thread and make the different parts of the bag, such as the handles and strips, easy to take apart for recycling. It is also possible to substitute metal parts with fabric loops or other creative designs to completely avoid the use of metal. This approach can be combined with mono-materiality strategies ensuring material cyclability.



- 1. Screwable metal rivets to enable future recyclability by Luna Mazzolini
- 2. Screwable detachable button by Nilorn
- 3. Screwable buttons for trousers by Freitag

Dissolvable and Separable Seams

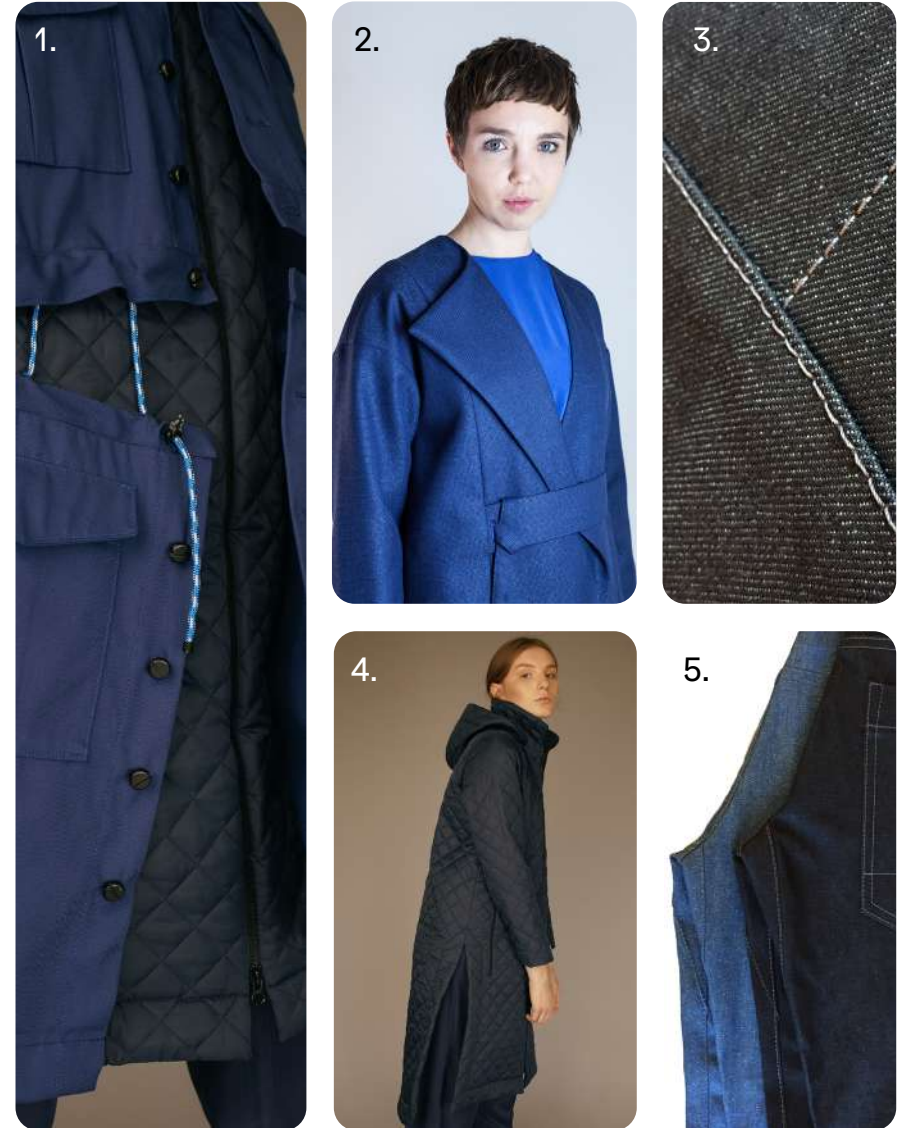
Design for Disassembly

In order to recycle garments, trims such as zippers and buttons need to be removed from the piece and textile components of different materials need to be separated. In many cases, this removal calls for manual assistance in cutting or ripping of the trims, which is both time-consuming and costly. To optimise the process and ensure a higher level of recycling, innovations like manual separable seams such as the chain-stitch or dissolvable yarns can have a large positive impact both economically and environmentally. Not only would it make recycling easier, but also enable repairability and reusability of a garment and its components. In cases where materials from different material cycles are needed to reach a desired functionality or aesthetic, dissolvable seams would play an important role in enabling these materials to be jointly combined in a traditional way, while at the same time being separable by the dissolvable thread. Dissolvable yarns can be soluble through water, heat and pressure or via hot air and microwave. In this case, the thread would simply dissolve, making trims like zippers and buttons fall off from the main fabric, which then can be reused or recycled.



Physical Durability

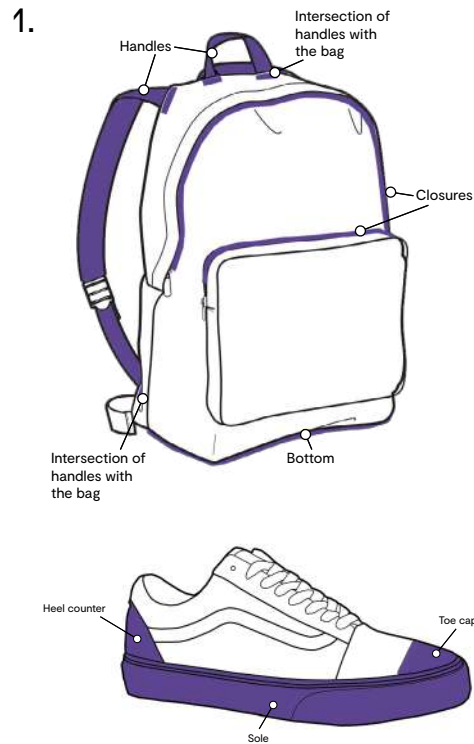
Physical durability refers to the fact that a product is made to last and can resist damage due to wear. The physical or functional durability of a piece is impacted by its construction and design and can be strengthened by careful selection of materials and trims that are of high quality, durable and fit for purpose. Physical attributes to consider when choosing materials are the fabric weight per unit area, the knit/weave construction and density, the tear strength, the shape resilience and abrasion resistance. Parts that are liable to stress, such as the crotch or elbows, can be reinforced by extra stitches to enhance durability. High quality knitted trims at neck, hems and cuffs can help avoid t-shirts and sweatshirts losing shape. Fabric finishes that address moisture, stains and odours can also be used for garments. Providing care instructions that communicate simple care, wash and laundry practices and encourage repair or reuse of the piece influences the user's behaviour to take care of the product which in turn can impact the durability and longevity of it.



1. Detachable thermo layer for seasonal use of a coat by Alberte Rothenborg
2. Durable wool material and timeless design for physical and aesthetic durability by Alberte Laursen Rothenborg
3. Reinforced stitching by Denim Footprint
4. Thermo vest for layering by Alberte Laursen Rothenborg
5. Thigh stress points reinforced by double layer fabric and enhanced stitching by Denim Footprint

Strengthening Stress Points

Physical Durability



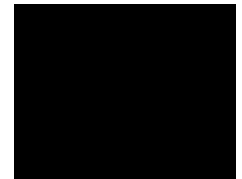
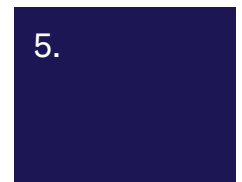
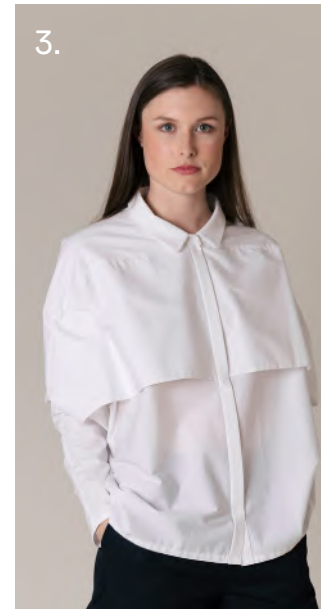
To ensure longevity of a product its functional durability must be considered and technically strengthened in the design. This can be done by reinforcing parts that are more liable to stress by wear and use, for example the elbows on coats and blouses or the inner thighs and knees on pants. Studying the use pattern of a product can be helpful to understand where design strategies to increase a product's physical durability need to take place. For example, a bag tends to break on the bottom, in the areas where the handles are attached and on the closings. A shoe generally breaks on the sole, the heel counter and the toe cap. Reinforcement of parts can be done by double stitching, double layers of fabrics or fixing stitches with a thick thread. It can also be achieved through creative stitches such as the manual saddle stitch that by its construction has one knot every punched hole, which results in higher durability than a normal machine stitch. Reinforcements can become part of a product's aesthetic and add new value to it. To further ensure the longevity and functional durability, a product can be accompanied by repair instructions or additional parts such as buttons and extra sewing thread to encourage the customer to repair the product.



1. Usage pattern of a bag showcasing stress points by circular.fashion
2. Usage pattern of a shoe showcasing stress points by circular.fashion
3. Reinforced stress point with a handmade stitch by Denim Footprint
4. Reinforcement of seam by Denim Footprint
5. Reinforced stress points by Denim Footprint

Aesthetic Durability

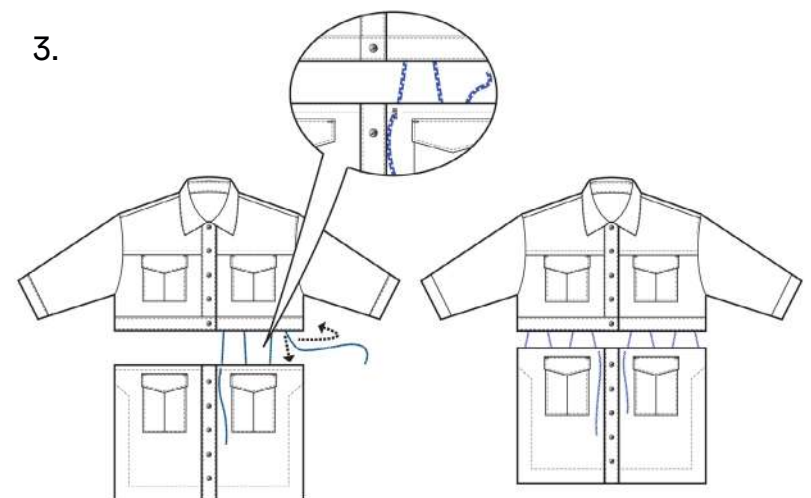
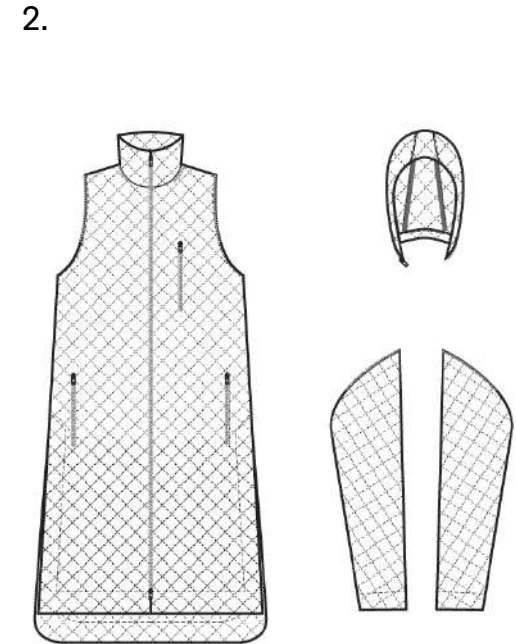
Within a culture of rapidly changing trends and desires, designing products to last is far away from the predominant fashion rhythm. Designing for aesthetic durability is about making a product last in style and to not become outdated after a season or two. Two strategies can be followed to increase the aesthetic durability of a product. Designing for 'the pleasure of the expected' is about moving away from bold trends, vogue styles and short-term desires and instead move towards classic, timeless designs. Designing pieces with elegant styles, harmonic shapes, easy-to-read, well balanced and with well proportioned cuts will improve the aesthetic durability of a piece while still give space to involve contemporary influences in the design. Choosing neutral colours, such as black and white or monochrome colour harmonies will ensure the piece to be more long-lasting as it tends to fit to various occasions and seasons. On the other hand, aesthetic durability can also be achieved by designing for 'the pleasure of the unexpected' and the creation of a one-of-a-kind piece that due to its uniqueness of aesthetics, colours and asymmetrical shapes is so interesting that it is kept for a long time.



1. Timeless silhouette and neutral colours by DfCxJNJ
2. Timeless silhouette in durable C2C certified wool by Alberte Rothenborg
3. Classic mono-material shirt in biodegradable polymer by DfCxJNJ
4. Classic culottes in biodegradable polymer by DfCxJNJ
5. Aesthetically durable color tones

Modularity

Modular design is a strategy that separates a product into smaller parts which independently can be used or be combined and used in new ways to create a more complex product. A modular product is built up by different building blocks that over time can be adapted to a user's needs, by adding or removing parts without altering the entire product. This strategy creates new functionalities and adapts the piece to different styles and needs. Also, it might help to overcome the risk of a user losing interest in the piece due to its dynamic adaptability abilities and extend its lifespan. Modular designs allows products to be customisable, adaptable, updatable or easily repairable in parts. This can prolong the life of a piece by strengthening the functional, emotional and aesthetic durability. Moreover, modular design influences the pattern construction of a product. Different parts need to be designed to be detachable and interchangeable through the use of different elements like zippers, buttons, loops, magnets etc. Besides flexibility in design and wear, modular design also facilitates recycling or reusing of materials and its components as the garment already at the outset is designed to be disassembled.



1-3. Trans-seasonal modular designs by Alberte Laursen Rothenborg

Transformability

To design for transformability is about making a product adaptable to various styles, fits, aesthetics and occasions. The strategy is based on the idea that a product's life ends because it is unable to adapt to changing needs and desires, and thus the user loses interest. To design for transformability helps overcome this challenge by designing a product that is able to transform aesthetically and functionally over time and recall the attention of the user every time it changes its appearance. Techniques to incorporate elements of transformability can be the use of drawstrings and buttons that alters the drape and look, innovative pattern construction that in itself holds several styles or adding elements such as a thermo layer to a trench coat, prolonging the use over seasons. A transformable product can ease the life of the user by being multi-functional, adaptable to multiple occasions and answer to different needs of size, style, body and personality. By fitting several user needs into one garment, we can support conscious consumption patterns and reduce the need to buy new pieces. The active role of the user to keep exploring a product can strengthen the emotional connection and has the potential to increase the longevity of the product.



1. Dress that aesthetically can transform its drape by Alberte Rothenborg
2. Jacket transformable into a vest and coat by DfCxJnJ
3. Transformable bag to multiple shapes and functions based on a mathematical study of paper patterns by Lim Sungmook

Redye and Redesign

Transformability

I Original design
SS17
Sales price: 180€

II First re-dye
AW17
Cost: 30€

III Re-design
SS18
Cost: 40€

IV Re-dye
AW18
Cost: 30€



To make a garment last not only in function but in desire and style, the use of design strategies for transformability and participatory design have great potential. If a garment is able to transform throughout its life to satisfy changing needs and desires and evolve in a mutual engagement with the user, it is likely that the use period will be prolonged. Simple alterations, such as redyeing a piece into a new colour or redesigning it into a new shape can add new aesthetic value and bring new life to it. In addition, the use of these strategies taps into circular retail models, where a product can have several points of sale throughout its life, by offering a variety of services. If a piece is stained, broken or if a user at any point is in need of alteration or simply lost interest in it, the product can be handed in for an update. This concept can also be done as a do-it-yourself guide, encouraging the user to participate in the design process. This can have a trickling down effect in other aspects of sustainable behaviour, such as building competencies for repairing, mending and caring for one's products.

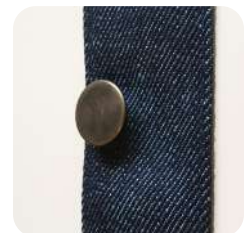


1. Redesign and redye service concept for Kerber by Jonna Haeggblom
2. The circular T-shirt comes with natural dye pigments for redyeing to engage the user in sustainable circular practices by circular.fashion

Detachable Elements

Repairability

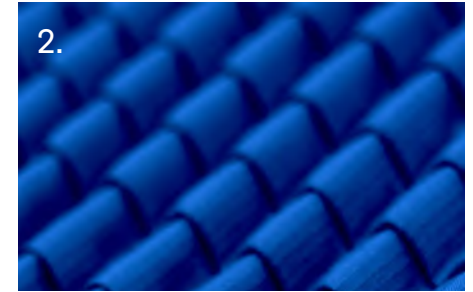
Even in cases where the functional durability of a product is well-thought-out, it might need repair in the future. To already at the outset, design it in a way that it can be easily repaired or reused in parts is an efficient way to make sure that it is kept in use. A piece can be designed with detachable and replaceable parts and constructed to be easy to disassemble. In this case, only the broken or worn-out elements, for example the collar on a shirt or the closure on pants, can be repaired or replaced instead of disposing the entire piece. Detachable elements also open up opportunities for customisation by offering exchangeable colours and materials which have the potential to increase the emotional durability through participatory design as well as adaptability in style. Promoting repairability strengthens the brand loyalty as it builds on a brand's reputation in creating pieces designed to truly last. To encourage customers to do easy repairs themselves, care and repair instructions can be provided with the garment. This can also be accompanied by retail models of repair facilities in store.



1. Detachable collar enabling easy repair and customisation by Denim Footprint
2. Detachable button row for repair and disassembly by Denim Footprint
3. Modular coat with zippable sleeves and hoodie by Alberte Rothenborg
4. Screwable detachable button by Nilorn

Adjustable Sizing

A common reason for a garment not being used as long as intended is the fact that it simply doesn't fit anymore. To design a garment with the possibility to be size adjustable over time has the opportunity to overcome this challenge and prolong the use of it. Simple design techniques for size adjustability can enable small alterations to changing personal measurements over time. To incorporate fit adjustments into the design can be for example having generous seam allowance that can be used to increase the width or length of a piece or the use of strategic fastenings to dynamically alter the size. Other mechanisms that facilitate size adjustability are drawstrings, adjustable side seams and hems, the use of additional buttons or elastic to refit an oversized garment and give more movability. Techniques in the pattern construction itself that facilitates size adjustability can be folding techniques, engineered to expand bi-directionally to mimic the growth for several sizes. Designing for size adjustability is especially suitable for products that would benefit from being able to grow along with the user, such as maternity-wear or kids-wear. Size adjustability have the potential to result in less overstock of products and avoid the risk of overproduction.



1. Top designed to fit 3 sizes by additional width added in armhole by DfCxJnJ
2. Garments of recycled polyester, engineered to expand bi-directionally to mimic the growth of children from 9 months to 4 years in 7 sizes, by Petit Pli
3. Wrap-closing for size adjustability in the waistline by Alberte Rothenborg
4. Generous seam allowance to adjust the width by Denim footprint

Emotional Durability

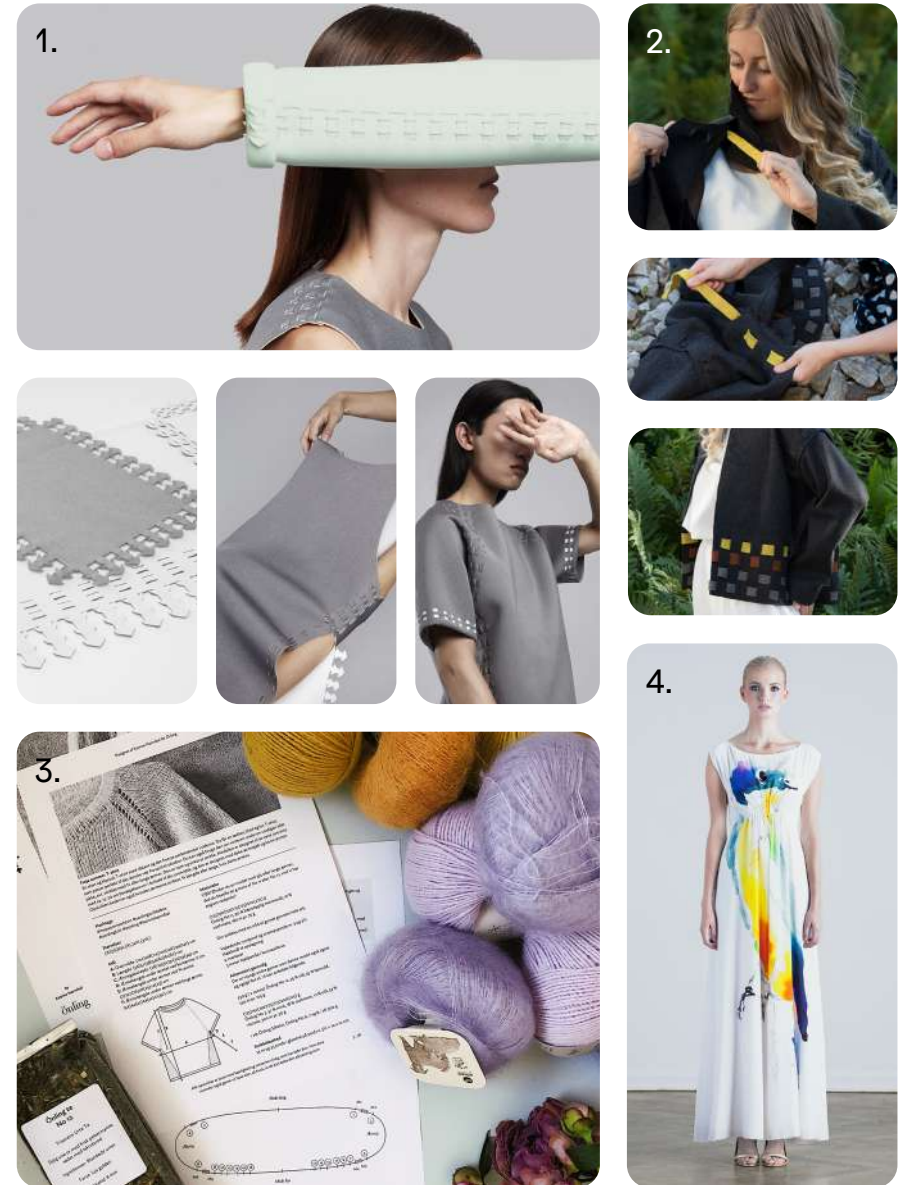
If functional durability refers to whether a garment by its physical attributes is made to last, emotional durability refers to whether a user wants to keep and wear it. Today's use of clothing is mainly characterised by short-term wear and disposability, where a garment generally is replaced due to the fact that a user has lost interest in it, rather than it being broken. To design for emotional durability is about creating pieces that consumers wish to keep and use for longer, through adding elements of mutual engagement and growth. Human beings are not static, but in continuous evolution, therefore also products need to follow this dynamic. Bringing the user into the design process by co-creation strategies, customisation and participatory design have great potential to enhance the emotional durability. This can be done by using materials that age and evolve gracefully over time revealing a pattern or drawing, enhancing a product with marks of wear and repair or including personal statements. Storytelling and transparency of production might build on a garment's narrative and strengthen the emotional connection. Other factors of influence are the comfort, fit and size and how well it emphasizes the users personality and by when, where and from whom the piece was acquired.



1. Customization and participatory design to strengthen a users emotional bond to one's piece by Jonna Haegglom
2. Ageing gracefully leather designed with a UV coating which tends to shine brighter activated by sunlight by Luna Mazzolini
3. The concept is to allow for easy, low skill engagement with the clothes, creating a patina of wear and a documentation of the stories by Julia English

Participatory Design

Participatory design strategies engage the user to be part of the design and/or making process of a product. Ways to include the user are for example with do-it-yourself kits and guides, open source designs of patterns or co-creating processes that can be either personal or automatic via digital platforms. For example, instead of buying a finished product, a user can buy only the parts and assemble it oneself. Exploring methods that actively involve the user can increase the emotional connection, resulting in pieces that are cherished and kept for longer. Participatory design opens the possibility to create garments that meet specific user needs and desires, but also show personal artistic skills, intensifying the feeling of creative talent and ownership of the piece. The desire of consumers to take a more active part in the actual design of a product is becoming more widespread today through maker culture. To include participatory design elements also have great potential to increase brand loyalty as well as an understanding of one's customers as it opens up a two-way relationship. Being part of the design process can also have a trickling down effect in other aspects of sustainable behaviours, such as building competencies for repairing or redesigning a garment.



1. Lasercut patterns available online to be assembled by the user by the Post-Couture Collective, Martijn van Strien
2. Updatable customization by Jonna Haegblom
3. Participatory knit design kit by Oeling
4. Crowdsourced designs and prints and tailor challenges by 13 Dresses UG

Updatable Customization

Participatory Design

To design a product that is updatable and customisable gives the user the possibility to change and adapt it over time. This engagement can foster a strong emotional connection to the piece and has the potential to prolong the life of it as well as open up ways to customise its aesthetic and functions to fit individual and changing needs and desires. An adaptable and updatable garment can give the user the perception that they own a product personally designed for them, increasing the feeling of authenticity and individuality in a world where mass-production of products tends to make them look similar. Ways of including elements of updatable customisation can be to provide letter-rivets so that the user can monogram a product or offering partial customisation, where certain elements of a product can be exchanged, such as the collar or cuffs of a shirt. Full updatable customisation can be done by giving the user the possibility to actively intervene on the full surface of the item by as the examples showcase intertwining strips of different fabrics and materials. By engaging the user to participate in the creation of the piece and offer the possibility to update it by changing colours and materials, the user can customise its look and alter its aesthetic over time.





CIRCULAR DESIGN KIT

Design strategies for material cyclability and longevity

Design plays a key role in creating a circular future for fashion. The circular design kit includes state-of-the-art strategies, solutions and product briefings on how to design fashion for circularity from a material cyclability and longevity perspective. Dive deep into strategies of mono-material, emotional durability, participatory design, transformability, disassembly and many more. The circular design kit lets you and your team explore how circular design strategies can drive sustainable change in the fashion industry and ensure that the products of today become the resources of tomorrow.

Together we can realise a circular future of fashion!

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