Circular design with next gen materials

Guidebook

February 2025

This guidebook was developed by Dr. Laetitia Forst as part of the New Composites project funded by the Future Observatory Design Exchange Partnership.

How to use this guide

The aim if this guide is to support decision making when using next gen materials in circular textile design.

In this guide you will find:

- An introduction to Next Gen materials in relation to circular design
- Questions to ask about circular materials and products
- A diagram representing recycling routes based on fibre types

The diagram informs decision making when combining different materials inside one textile. You can use it to check whether a combination will enable or limit recyclability at end of life.

This is the online version of the guidebook. A printable version, that can also be used by facilitators to accompany a creative brief with groups of makers can be found online.

Why do we need next gen materials?

Alternative materials from recycled fibres, regenerative agriculture, or bi-products of other industries have a role to play in making textiles more sustainable. They can help reduce our dependency on a narrow range of fibres which tax the earth's resources and make us vulnerable to changes in climate and geo-political situations. By using a larger range of materials, we can make the textile sector more diverse and more resilient.

How can we make next gen materials circular?

Circularity is currently focused on widely used polyester or cotton fibres. As we shift to using more alternative and sustainable fibres, we must not forget to make them last for a long time in products, and enable their recycling at end of life. Often fibres need to be mixed to achieve best performance, but some blends can make textiles difficult to recycle. To make next gen materials circular, we must consider how they can be recycled and only mix them with fibres that can be recycled in the same technology, or design them to be disassembled before recycling.

A hierarchy of recycling

Recycling technologies are constantly evolving, the aim being to reach a high-quality new fibre from waste textiles as efficiently as possible. Mechanical recycling relies on pulling fibres out of waste textiles to re-spin them as yarn. In the process fibres are often shortened, requiring a portion of new fibres be added to increase overall strength. With this technology, the colour of the waste and any other 'contaminants' like other fibres or finishes are also present in the recycled yarn. Chemical recycling can extract impurities but requires more energy and chemicals to achieve this result than some mechanical process. Biodegradation will return the fibres to the soil where they can contribute to the next cycle of growth, this path is hard to measure as a circular process, but it can avoid fibres going to landfill or incineration.
In each case, recycling technologies are specific to one or a set of fibre types and have parameters for appropriate waste input.

Speculation on future recycling landscapes

Currently, efforts towards circularity are focussed on the most used fibres: cotton and polyester. This research projects into a future where all fibres are included in a circular textile economy. Some assumptions are made concerning the development of recycling technologies to accept a wider range of fibres.
In conversation with recycling experts, developments that can be projected based on current research have been represented in dashed lines in the diagram.

Selected next gen examples

his guidebook does not cover all material pathways. A selection of next gen materials was used to exemplify a way of thinking about combinations in relation to circularity: bio-polyester, recycled wool, recycled cotton, regenerated cellulose, and pineapple yarn. The trajectories to recycling are therefore limited to general directions for these five fibres and more conventional fibres that they could be blended with.

Questions to ask yourself when starting to work with Next-Gen materials in circular design

Use these question to know your material or product in more detail, annotate with answers or points to follow up with your supply chain.

1. In what form is the raw material found? Will it need to be transformed or treated to become a textile fibre?

2. What recycling system is the raw material best suited to? (see diagram on pages 6 and 7)

3. Are several fibres mixed together to make the yarn or the textile? Are these compatible for recycling?

4. What dyeing and finishing processes will the fibres undergo? How will this impact their recyclability?

5. How is the textile integrated to a product? Is it mixed with other materials through sewing or with trims?

6. How can the textile design contribute to an extended product lifecycle? Might blending for durability affect recyclability?

7. Might any repairs affect the recyclability of the product?

Your Notes

Polyester is the most commonly used fibre in fashion. It is very versatile and its ability to be melted and re-formed into new fibres, has made it a key focus for recycling.

Bio polyester looks and feels like fossil based polyester but it is transformed from biomass rather than from crude oil. In theory it can be re-cycled in the same way.

Wool is grown as the hair of animals such as sheep or alpacas. It is a fibre which has a long history of recycling.

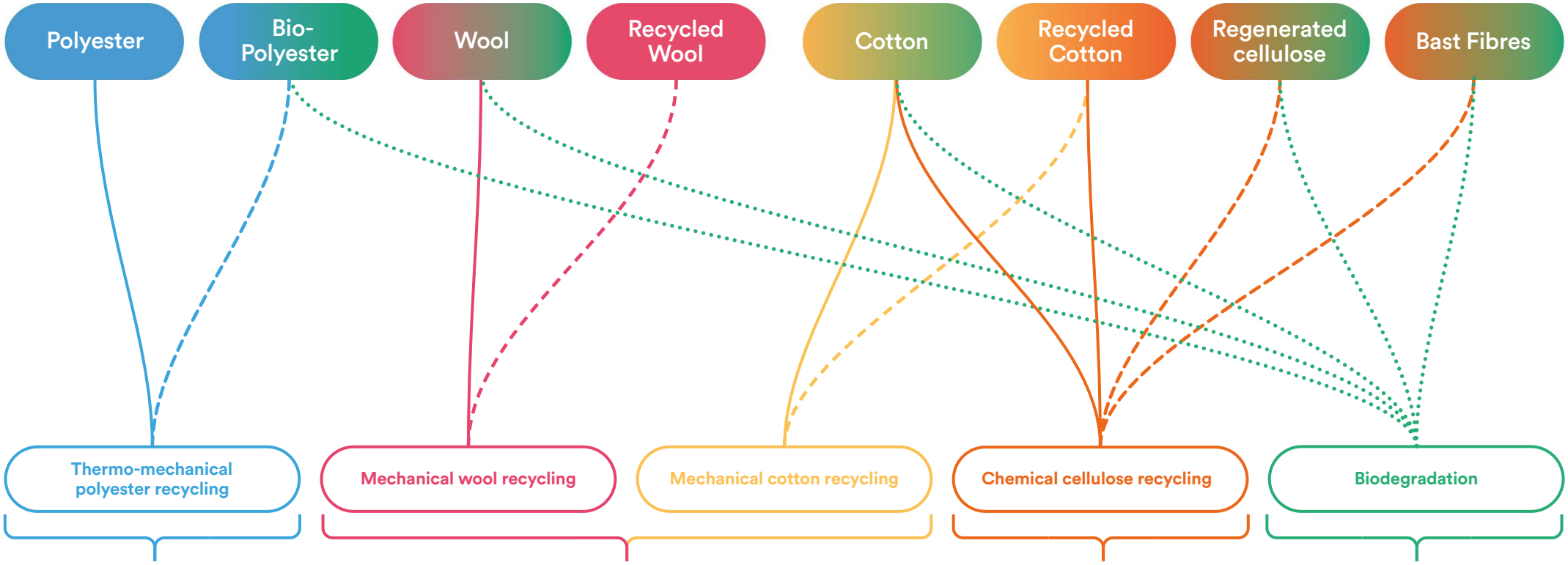
Recycled wool is made from waste wool garment or the production offcuts. Waste is pulled back into fibres to spin a new yarn. Recycled wool conserves the colour and any other finishes from its previous life.

Cotton fibre comes from the flower of cotton plants. It is the second most used fibre and therefore has been a focus for recycling technology.

Mechanically recycled cotton is made from waste garments or from production offcuts. Waste is pulled back into fibres to spin a new yarn. Recycled cotton conserves the colour and any other finishes from its previous life.

Regenerated cellulose is produced by chemically dissolving cellulose from waste textiles or from plants to make a new artificial fibre like viscose.

Bast fibres are extracted from the stem or leaves of a plant such as hemp, flax, banana (abaca) or any other fibre-containing plant.



Input must be 100% polyester. Colour and contaminants will remain in the output.

Input must be mono-material with an allowance for 5% other fibres. Colour and contaminants will remain in the output.

Input should ideally have high cellulose content. Allowance for other fibres varies depending on recycler. Colour and contaminants will be removed in the process.

Biodegradation will contribute the waste to soil, this is an open loop end of life trajectory. Currently it is difficult to guarantee that textiles will reach facilities which will industrially biodegrade clothing, but if the waste ends up in nature it may be less damaging.

*Diagram-key on next page →

Diagram Key

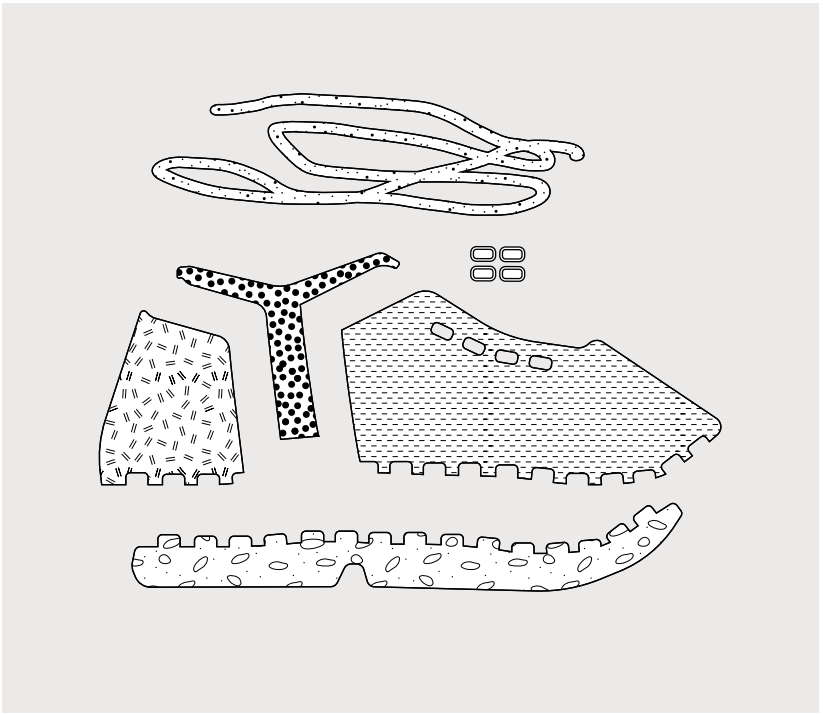
Solid Line:
Current recycling route at scale

Dashed Line:
Speculative recycling route based on technology development

Dotted Line:
Open loop end of life through biodegradation, currently not operating at industrial scale for textiles

Design for Disassembly

If the performance and desirability of the textile depends on a combination of resources which cannot be recycled together, then a design for disassembly approach can be taken. This will require more steps to recycling and is currently not part of sorting and recycling systems.



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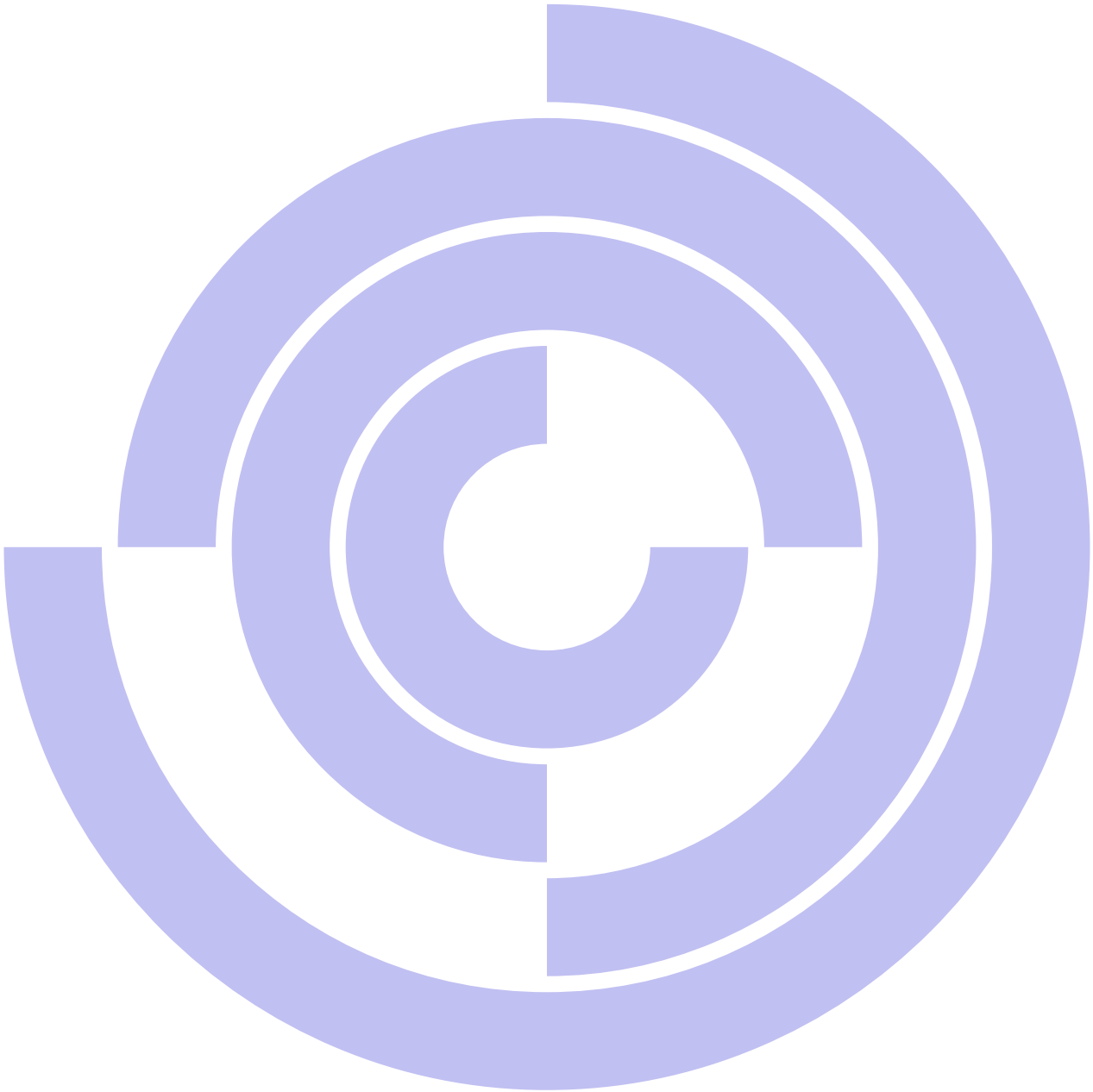

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