

Insights into
Future of Textile Materials

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Aalto University

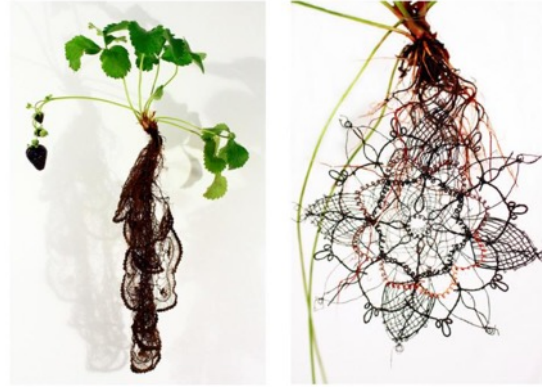
Speculative design or material innovations?



Biocouture jackets made of cellulose material

Suzanne Lee

https://www.ted.com/speakers/suzanne_lee

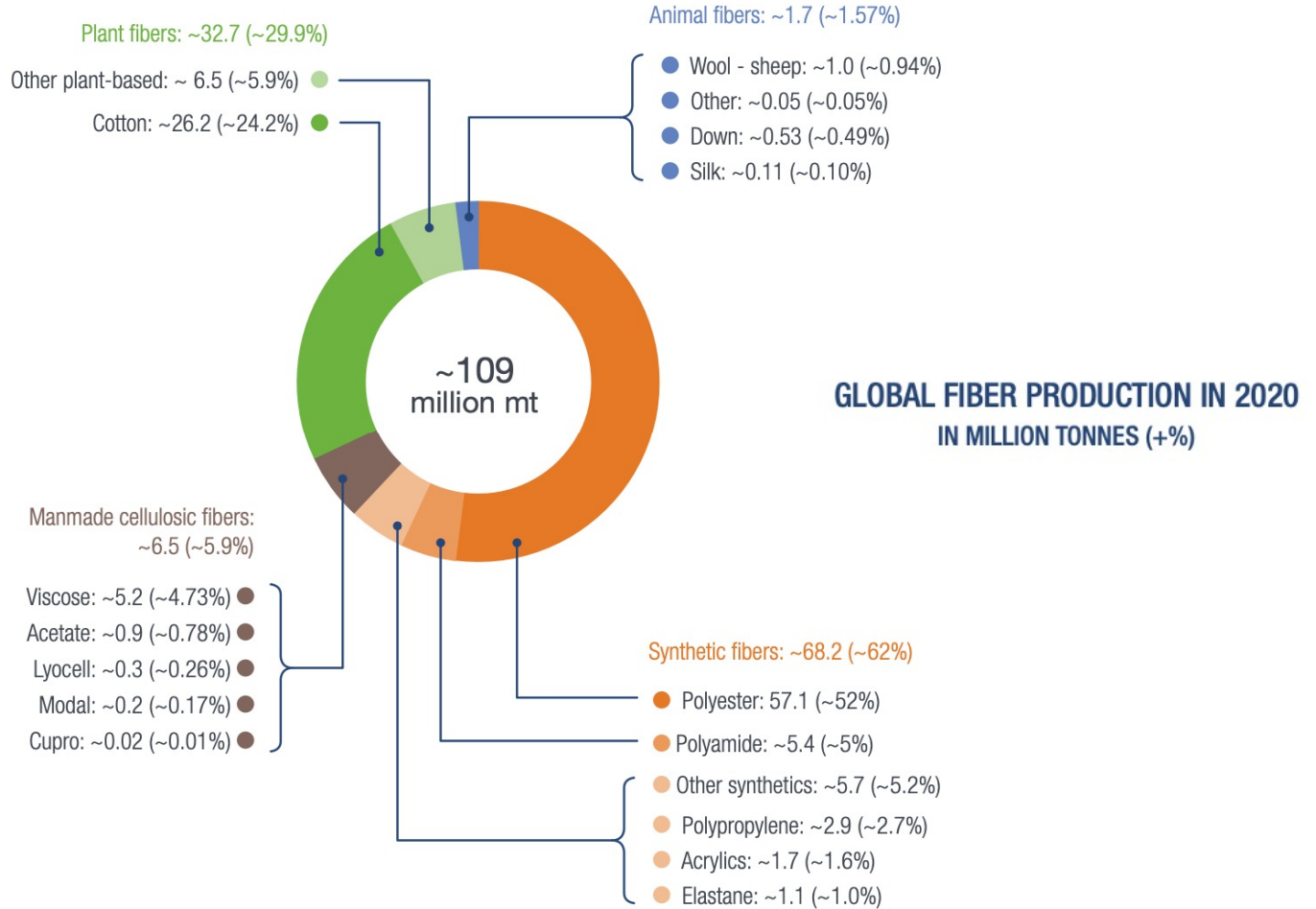


Biolace by Carole Collet

State of the Art

- **Materials**
- **Production technologies**
- **Long value chains**
- **Collaboration**

Materials



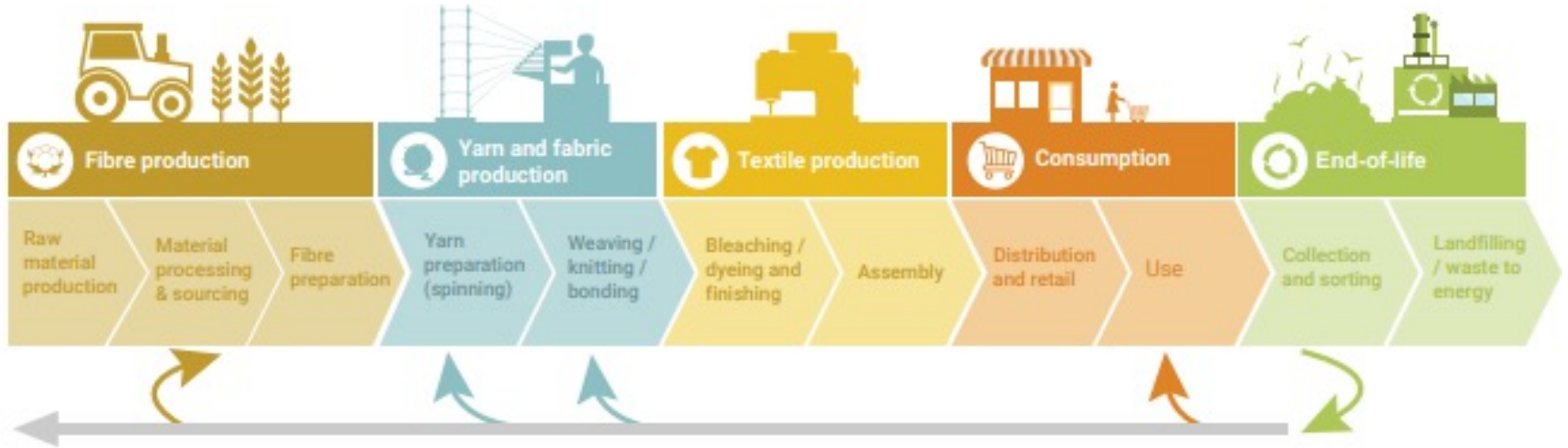
Three main production technologies

- 1) Weaving
- 2) Knitting
- 3) Non-wovens and felting

(also others)



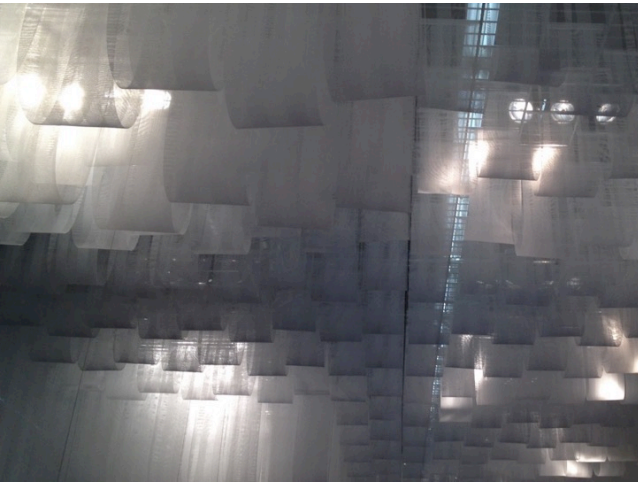
Long value chains



https://unemg.org/wp-content/uploads/2021/09/Panelist-Presentation_UNEP.pdf

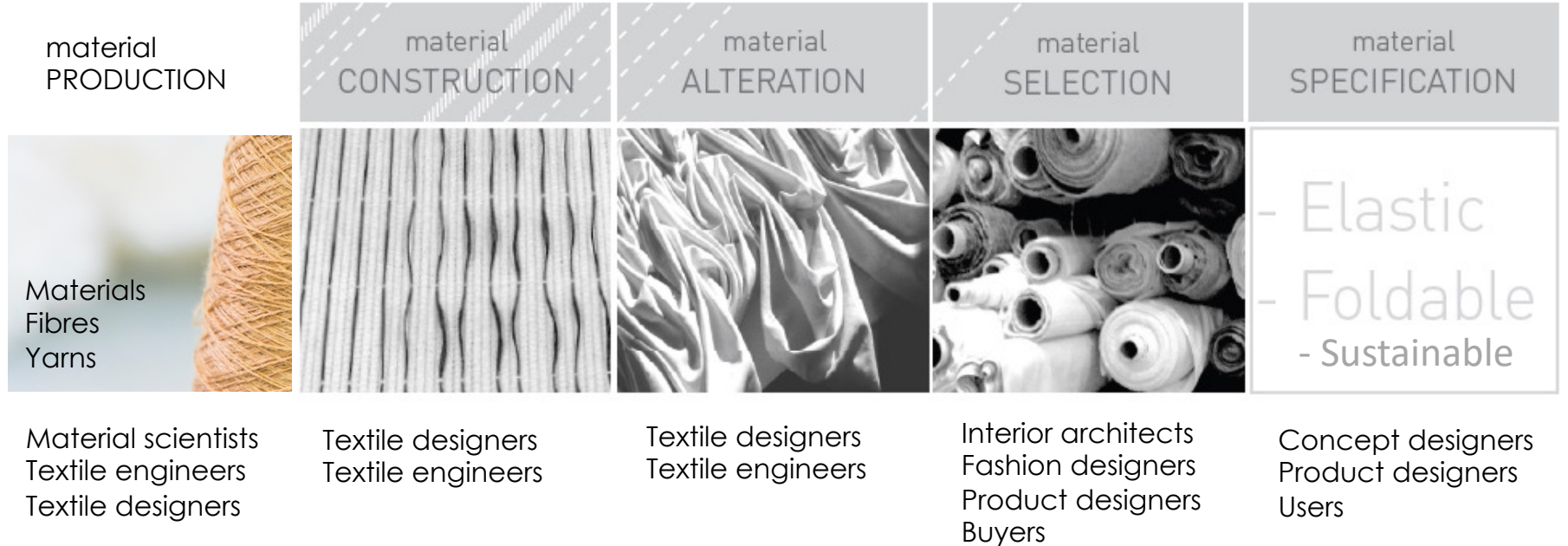
Textiles categorized by the use

- 1) Fashion and clothing
- 2) Interior textiles for home and public spaces
- 3) Technical textiles, e.g materials for construction, hygiene products, medical purposes, safety gear...



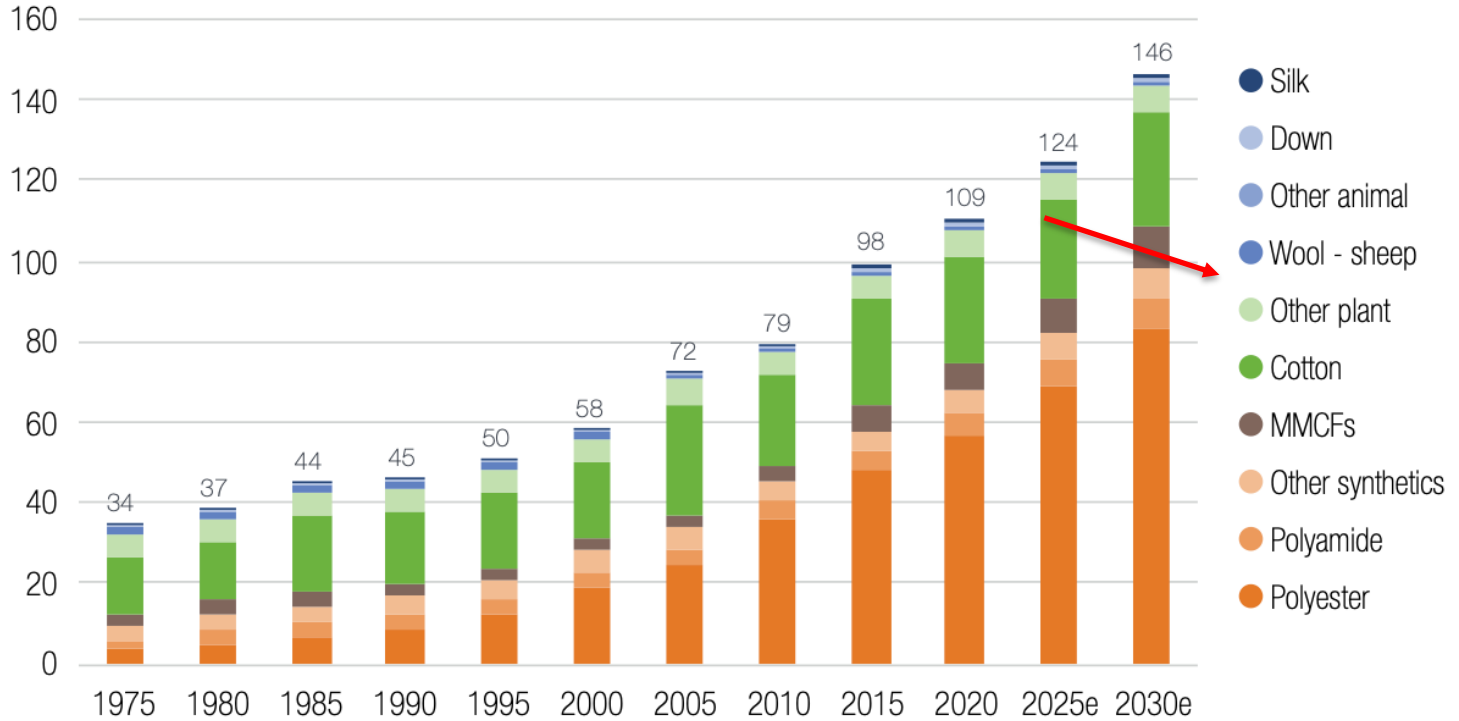
loncell by Anna Semi & Sofia Ilmonen 2019
Photo: Juho Huttunen

Forms of textile design decisions present in product design process



Future of Textile Materials

GLOBAL FIBER PRODUCTION IN MILLION TONNES



The State of Fashion 2021



McKinsey
& Company

BOF

A More Circular Fashion Industry Will Require a Collective Effort

As consumers become more engaged with sustainability issues, circularity will be the key that unlocks the door to a more sustainable future.

by Libbi Lee and Karl-Hendrik Magnus

Key Insights

- With garment production volumes growing by 2.7 percent annually and less than 1 percent of products recycled into new garments, action on circularity is an imperative.
- Despite challenges with garment durability and logistics, pioneering brands are driving circularity from the drawing table to e-commerce search filters.
- All fashion value chain stakeholders have a role in driving the circularity revolution — we expect it to be the next disruption, and it's for individual brands, manufacturers, aggregators and marketplaces to capture the opportunity before others.

The State of Fashion 2022



McKinsey
& Company

BOF

07. CIRCULAR TEXTILES

One of the most important levers that the fashion industry can pull to reduce its environmental impact is closed-loop recycling, a system which is now starting to be rolled out at scale, promising to limit the extractive production of virgin raw materials and decrease textile waste. As these technologies mature, companies will need to embed them into the design phase of product development while adopting large-scale collection and sorting processes.

Source: State of Fashion report by Business of Fashion & McKinsey, 2020

Source: State of Fashion report by Business of Fashion & McKinsey, 2021

A!

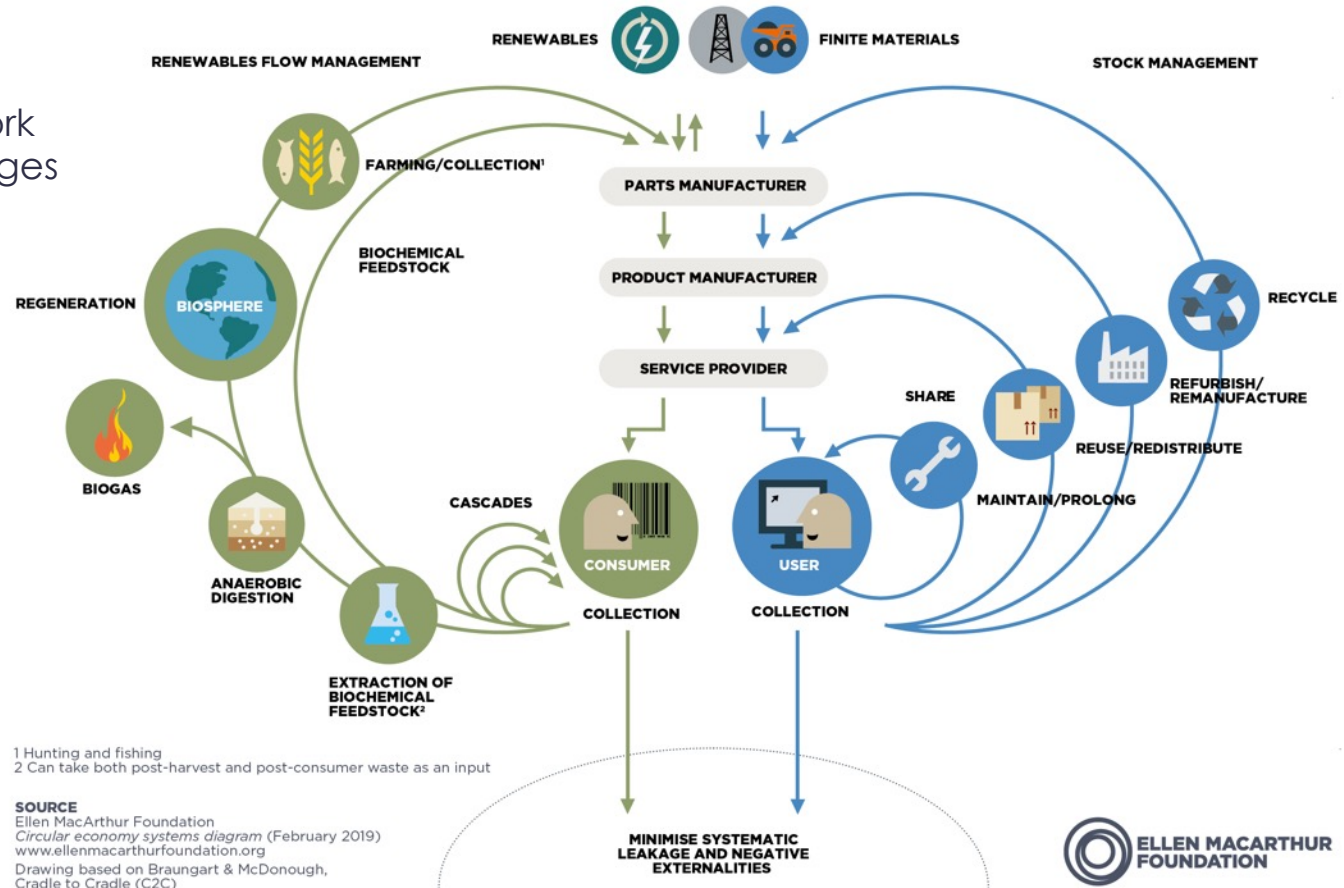
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Our material world is changing

1. Circular economy
2. Material research for innovative use of raw materials
3. Digitalisation and automatisisation continue
4. Biofabrication (use of biological processes)
5. Designing new materials, for example with synthetic biology

1. Circular economy

The circular economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution.





Collector Square

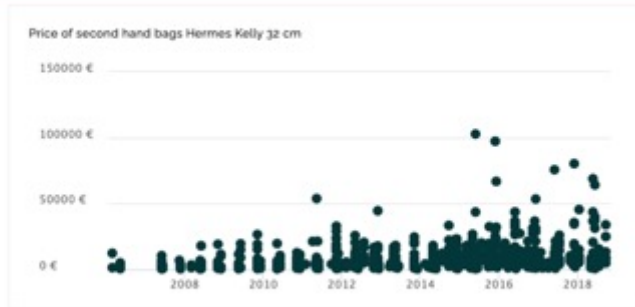


Advanced Previews

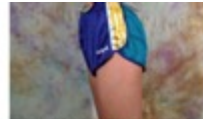
Watches

Jewellery

Bags



*LuxPrice-index is the valuation index for luxury watches and bags with nearly 300.000 auction sales results from the major auction houses in the world.



Adidas Vintage Women's Booty Sho...
GodzilVintageGizos
★★★★★ (174)
€24.15



vintage 70s 80s Adidas trunks shor...
CarnivalOfTheManiac
★★★★★ (2,938)
€38.90
Only 1 available and it's in 4 people's carts



vintage ADIDAS shorts cotton Size ...
widDushy
★★★★★ (483)
€35.40



vintage ADIDAS ORIGINALS track s...
widDushy
★★★★★ (483)
€43.20
Only 1 available and it's in 1 person's cart



vintage ADIDAS ORIGINALS track s...
widDushy
★★★★★ (483)
€39.70
Only 1 available and it's in 1 person's cart



vintage ADIDAS ORIGINALS track s...
widDushy
★★★★★ (483)
€64.99
Only 1 available and it's in 4 people's carts



Authentic Shorts Adidas 1980's Vint...
VintageMailons
★★★★★ (99)
€59.99



Vintage 1980's or 1990's Adidas 5wL...
VintageFindMichael
★★★★★ (313)
€34.49
Only 1 available and it's in 1 person's cart



1980s Adidas Shorts - Vintage 80s ...
mjumayu
★★★★★ (332)
€69.00



vintage ADIDAS ORIGINALS track s...
widDushy
★★★★★ (483)
€40.60
Only 1 available and it's in 2 people's carts



Reuse – fashion and luxury



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The circular economy is based on main three principles, driven by design

- Eliminate waste and pollution
- Circulate products and materials (at their highest values)
- Regenerate nature

'In circular economy materials are not only reused or recycled; they are merely stored in products, and used again and again'

Prof. Mark Hughes Aalto CHEM

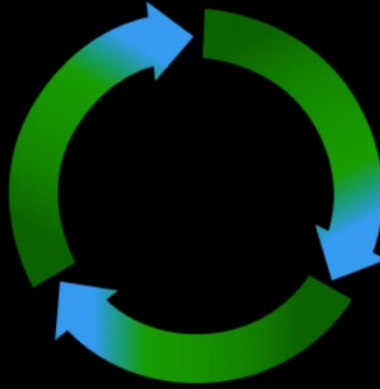


Adidas Futurecraft shoes made of monomaterial to enable recycling

Sustainability

Circularity

Regeneration



Do
less harm

Design
out waste

Replenish
and restore



Do less harm

Example: Several new man-made textile fibre production technologies in Finland

More information:

ioncell.fi
spinnova.com
infinitedfibre.com
metsagroup.com
nordicbioproducts.fi



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Ioncell

- **Company:** Ioncell
- **Origin:** Aalto University
- **Technological innovation:** High-quality textile fibres by dissolving cellulose with non toxic ionic liquids
- **Feedstock:** Cellulose-rich virgin or waste materials
- **Business status:** Small scale pilot at Otaniemi, Espoo.

<https://ioncell.fi>



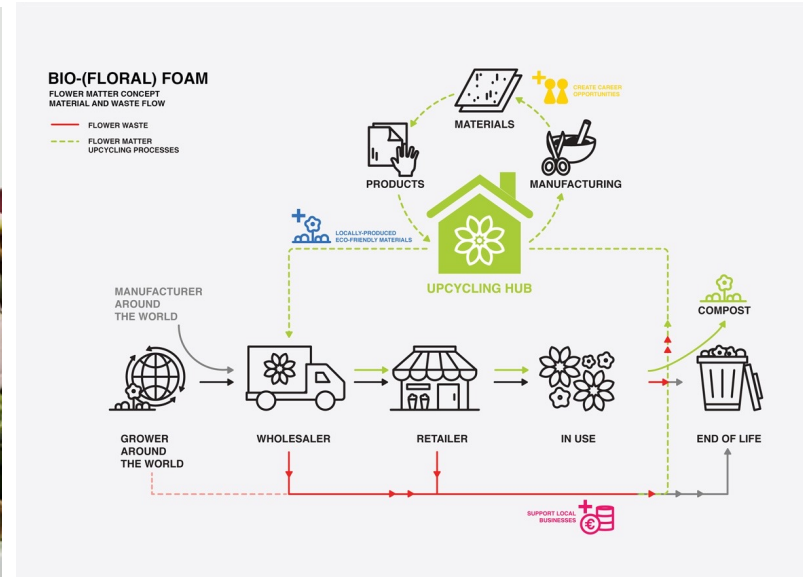
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Ioncell dress project 2018
Photo Vesa Moilanen/Lehtikuva

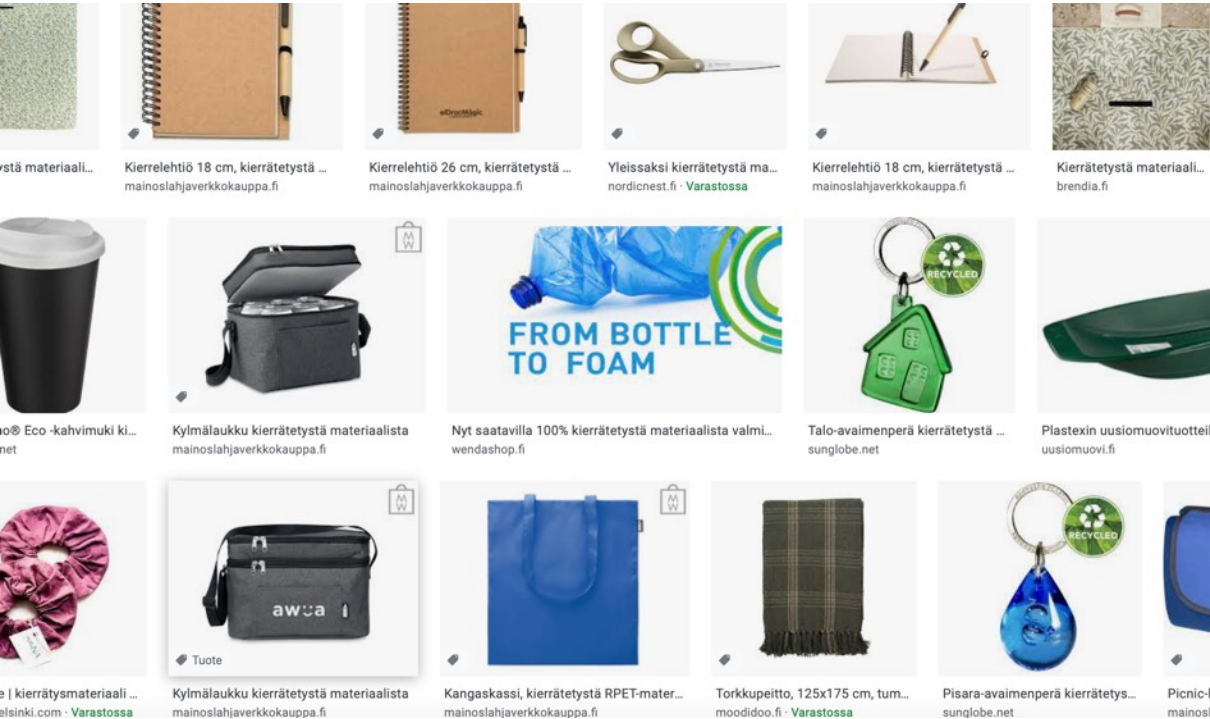
Design out of waste

Example: From flower waste to products – transforming materials and systems

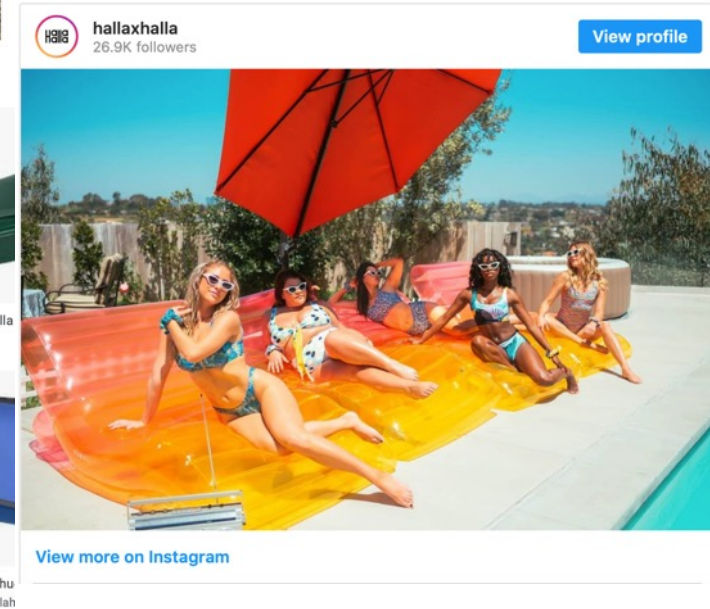


irenepurasachit.com

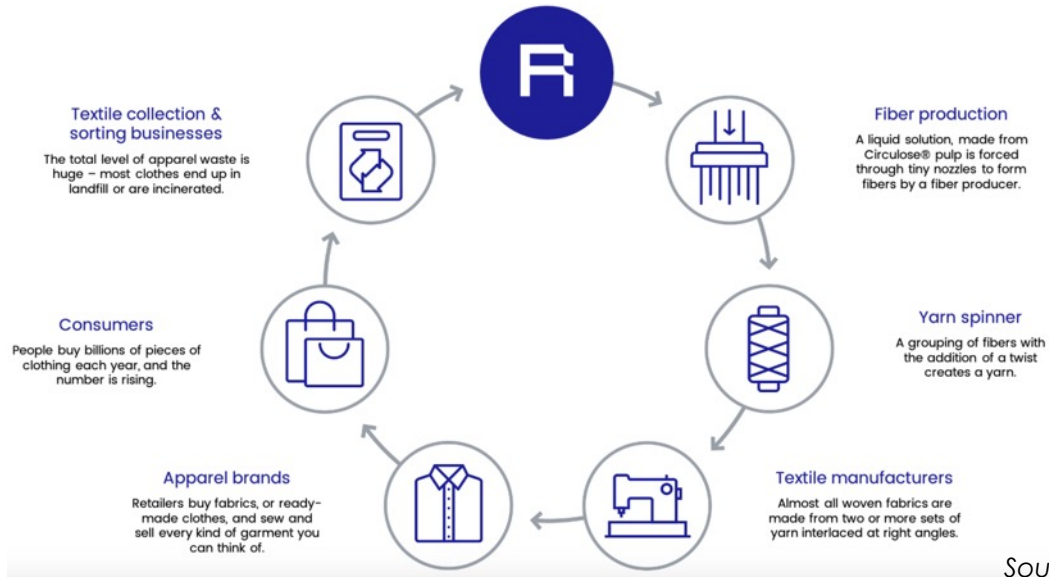
Upcycling plastic waste is great



Halla Hallan pirteät bikinit ja uikkarit ovat olleet pinnalla jo muutaman vuoden ajan. Perustajat Salla Valkonen ja Hanna Chalvet saivat idean uikkarimerkkiin huomattessaan matkoillaan, miten paljon meressä kelluu muovijätettä. Halla Hallan uima-asut tehdäänkin merten jätteistä valmistetusta Econyl-kankaasta, ja myös nämä uikkarit ommellaan Balilla.



Our recycling technology dissolves used cotton and other natural fibers into a new, biodegradable raw material, Circulose® pulp. Our customers use it to make biodegradable virgin quality viscose or lyocell textile fibers. This is the link that has been missing from the cycle. We have closed the loop. The way fashion is produced and consumed can finally be transformed into a never-ending loop.



Source: renewcell.com

Replenish and restore

Example: Transforming systems towards positive 'handprint'



HOME PROJECT TEAM NEWS CONTACT

ENCOURAGE HEMP AGRICULTURE

One of our goals with the Iroony project is to extend hemp agriculture, in order to benefit from its various ecological assets.

WATER

According to OECD 70% of water used worldwide is for crop irrigation. So not only is the agricultural sector the largest consumer of water but it's also a major polluter of water. At the same time, this sector faces increasing water risks, with major droughts.

Fortunately, growing hemp displays many characteristics that have advantages over other agricultural crops. Hemp as a plant is not only highly resistant to drought, but also to pests and pathogens. Therefore its culture does not usually require irrigation or chemicals, preserving water both in terms of quantity and quality.



**FLUFF
STUFF**

We replace unsustainable
textile fillings with plant-
based alternatives

Source: fluffstuff.fi

What if a textile filling could be carbon-negative, promote peatland ecosystem restoration and curb animal cruelty?

Fluff Stuff replaces unsustainable textile fillings with a natural alternative, fostering sustainable farming practices.



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2. Material research for innovative use of raw materials

Cellulose is the most abundant organic polymer in the earth
- it is in wood, plants, algae.

Cellulose can have very different formats.

Renewable
Recyclable
Functional



Trees and plants contain also lignin, hemicellulose, bark, long bast fibres, extractives for colours and natural 'chemicals'...



Wheat straw -based textile fibres



Soy fibres | Soysilk



<https://orangefiber.it>



Corn fibre | DuPont Sorona

Man-made textile fibres are produced mainly with chemical processes.

NOTE: Raw materials and textile fibre production technology are different things.

Lignin + textiles



Photo: Ines Jakovlev

By Pia Johansson in collaboration
with Biocolour research project 2021-22



Photo: Anne Kinnunen

Helena Sederholm in collaboration
with Prof Hummel's team 2023

Hemp, linen, nettle...



devo
home.com



Ecologically Efficient Agri-Food Systems for
Development of Advanced Textiles Supply
Chain - Production of nettle (*Urtica dioica*) for
regenerative fashion

Samica Sadik Summer 2021
PhD. Student (University of Helsinki Dept. Craft studies, Milano Politecnico)
MSc Agricultural Economics & Business Administration (University of Helsinki)



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Samica Sadik



Natural dyes
Aleksandra Hellberg & Jenny Hytönen
Aalto Chemarts 2019. Kuva Eeva Suorlahti



Dyeing with coffee waste Natural Indigo Finland + Paulig 2023



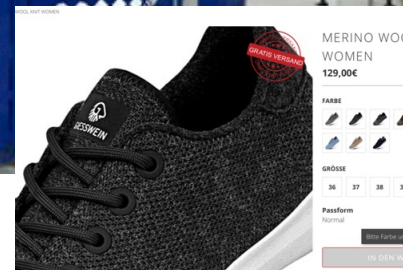
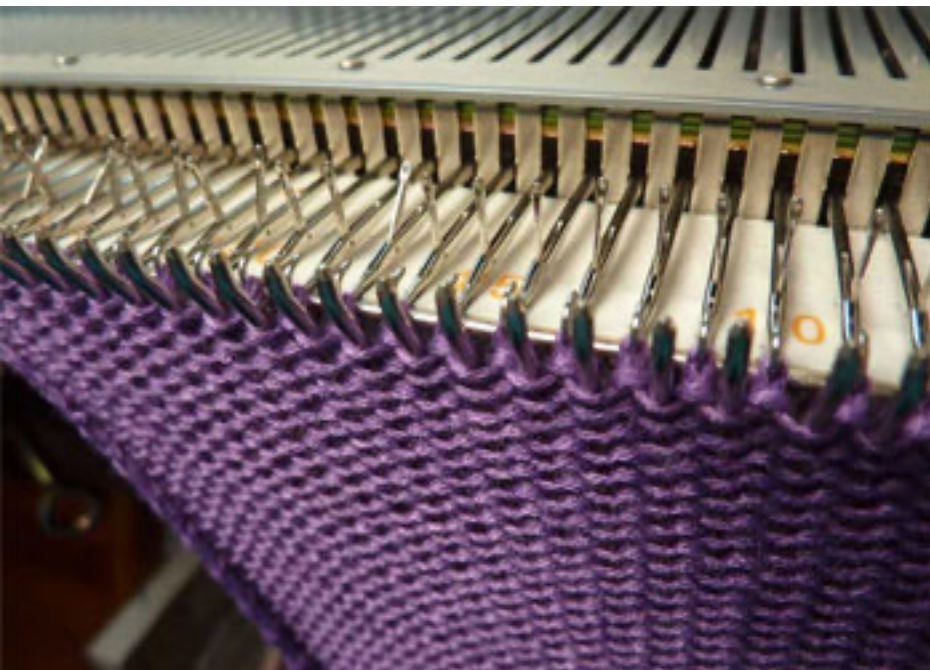
Natural Indigo Finland & Marimekko 2021
Kuva Mikko Raskinen.

3. Digitalisation and automatization continue

“There is so much within fashion that is unexplored.” — Iris Van Herpen



Iris Van Herpen via Paper Magazine

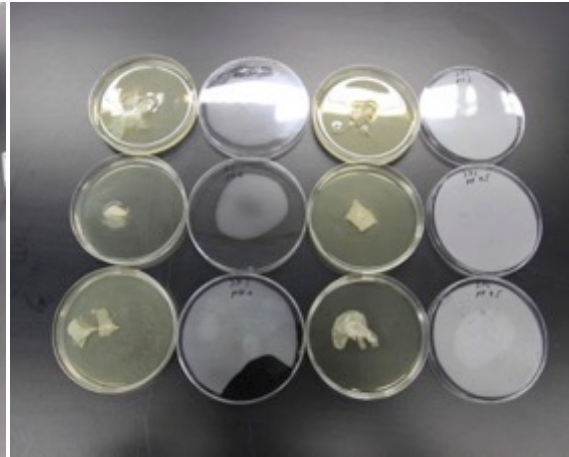
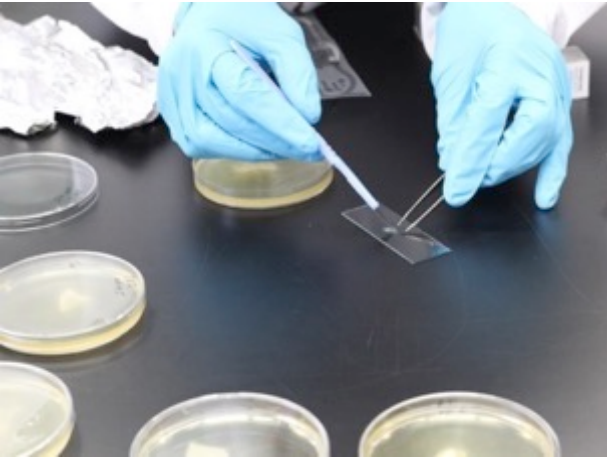


3D Additive manufacturing?
Traditional crafts / Super efficient, digitalized industrial processes



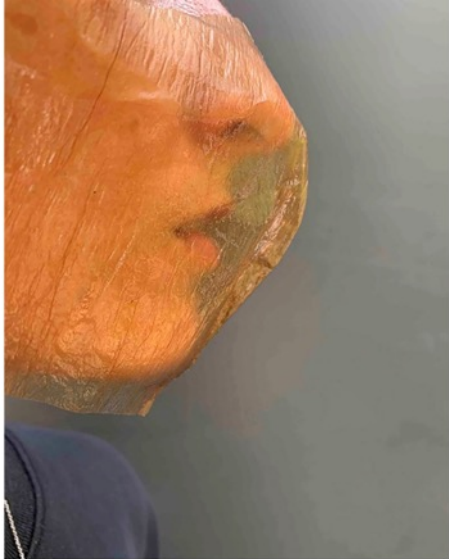
4. Biofabrication - use of biological processes

(with microbi, yeast and fungi)



Complex structures of microbial cellulose grown by Prof. Orlando Rojas's team 2018, Aalto University

'Have you seen this recipe to grow your jacket?'



A bio-design studio has grown the material in their home kitchen for a protective mask made of xylum. Photo: Elizabeth Bridges and Garrett Benisch, Sum Studio.

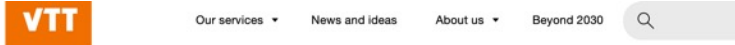


Textile-like materials from microbial cellulose and other bio-based materials. Julia Strandman, Aalto University CHEMARTS 2018.
Photo Esa Eeva Suorlahti



Experimental mycelium jacket By Anielia Hoitnik
<https://neffa.nl/portfolio/>

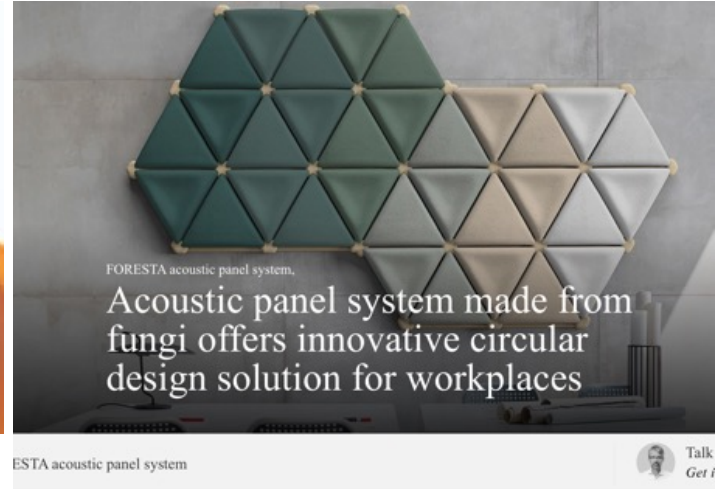
Materials with fungi (mycelium)



Home > News and Ideas > An alternative for leather and synthetic leather: VTT succeeded in demonstrating continuous production of mycelium leather

An alternative for leather and synthetic leather: VTT succeeded in demonstrating continuous production of mycelium leather

<https://www.youtube.com/watch?v=vj0-94b-2S0&t=2s>



Biologically produced Biology vs. synthetic biology



zenaholloway.com



dianascherer.nl



biofabricate.co

5. Designing new materials, for example with synthetic biology



Combining artificial silk-like proteins with cellulose, NewSilk project, Aalto University

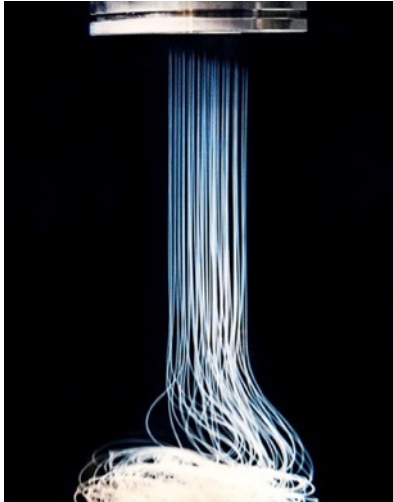


Transgenic glowing silk. Fantasma by Another Farm et al. Japan.



*Pigments of Micro organisms
Master's thesis on microbial colour
by Eveliina Juuri, Aalto University 2020
photo Eveliina Juuri*

'Let's brew for a pullover!'



Microsilk by Bolt Threads, U.S



*Stella Mc Cartney
x Bolt Threads*



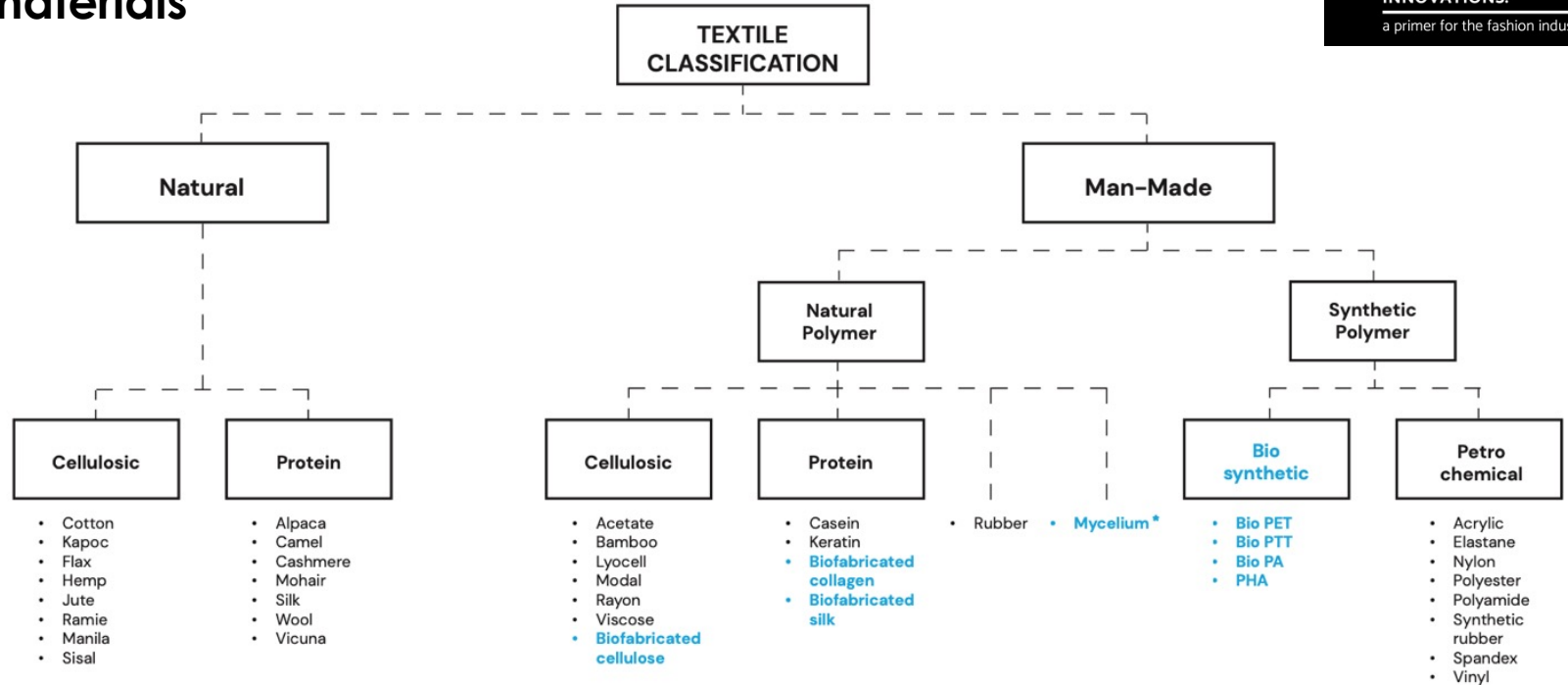
Brewed Protein by Spiber



New kind of textile factory: Brewed Protein by Spiber

Source: 'Understanding 'Bio'material Innovations' report 2020. biofabricate.co

New materials



*Mycelium is one of nature's composites comprising mainly of protein, cellulose and chitin.

HOW?

How to be a designer in this fuzzy world of emerging materials?



Keywords

Curiosity

Creativity

Collaboration

Communication

Critical thinking

Complexity > Persistence



CURIOSITY

Follow material development
and new technologies



***Design to Fade* - PUMA x Streamateria biodesign project explores sustainable ways of producing and dyeing textiles**

DESIGN TO FADE **LIVING** LIVING COL

COLOUR

The Living Colour products are made using a dyeing method that employs no hazardous chemicals, less water and less energy minimizing the negative effects on the environment. Designs and designers benefit by tapping into the global supply chain helping to shape a better world.

DESIGN TO FADE

Source: streamateria.com

CREATIVITY

Changing perspective: problems might be possibilities

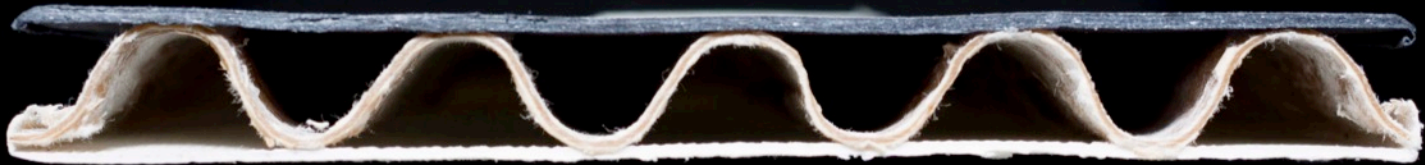
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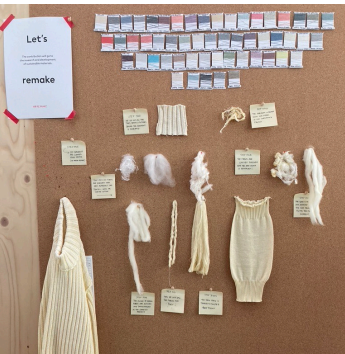
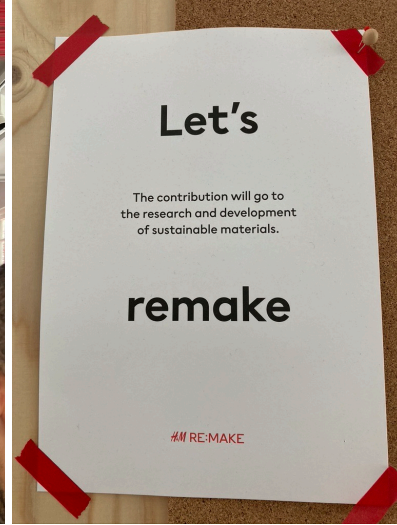
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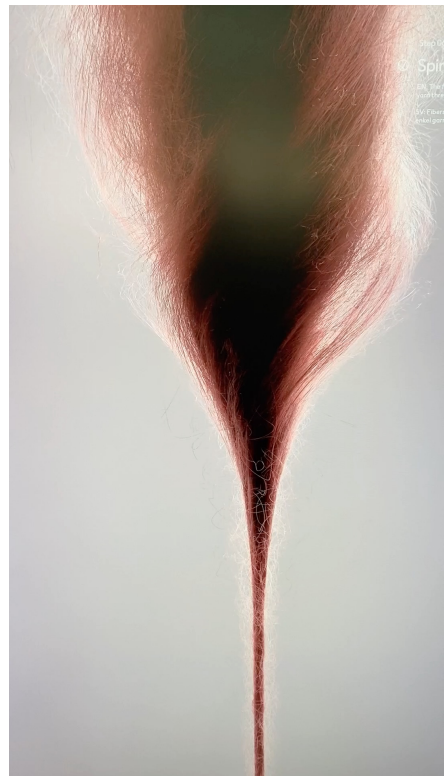
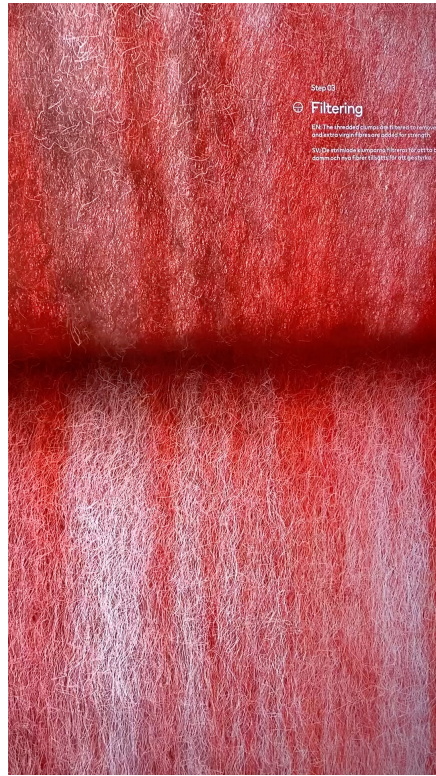
COLLABORATION

'The challenges to our planet are so complex that they cannot be solved by one discipline. Design is a bridge. It translates scientific ideas and discoveries into real-world applications.'

*- Matilda McQuaid, Curator at Cooper-Hewitt Smithsonian Design Museum, NYC
in the exhibition catalogue: 'Nature: Collaborations in Design', 2019*



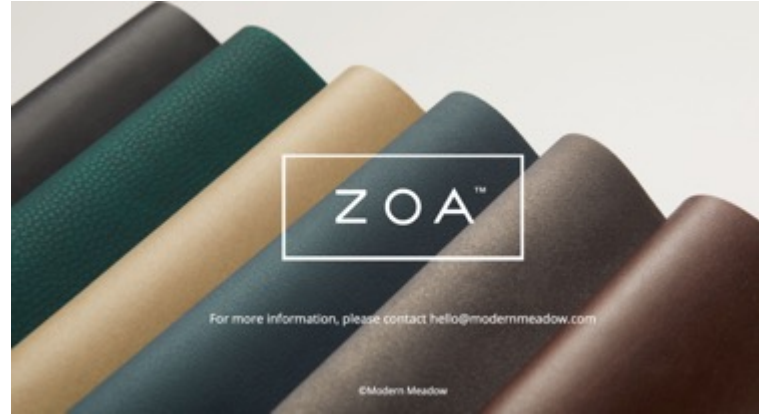






/ #MadeFromPiñatex

Piñatex® is a versatile natural textile, suitable for use as a leather alternative from fashion to furnishing.

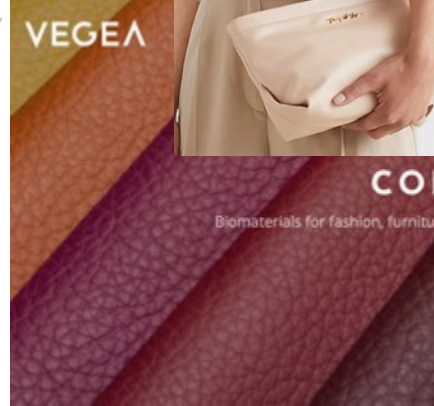


Replacing leather – but what about material sustainability?

MEET MYLO™

Made from mycelium, the underground root-like system of fungi, Mylo™ is a bio-based leather alternative that is soft, supple and less harmful to the environment.

The material that sparked a “mushroom leather” movement, Mylo is made possible by the world-class scientists and engineers at Bolt Threads and is backed by pioneering brands like adidas, lululemon, Stella McCartney, and more.



COMPANY

Biomaterials for fashion, furniture, packaging, automotive & transportation



EPHEA

An unprecedented class of naturally superior, functional, high quality materials, for fashion and beyond

With EPHEA™, SQIM brings to market an entirely new class of flexible mycelium materials.

EPHEA™ is not a leather replacement, but rather a set of products setting a new standard, thanks to the values, functionalities and mycelium-based biofabrication.

KEY INSIGHTS

- Brands are using buzzy but vague marketing terms like “vegan leather” and “plant-based” to describe materials with vastly different properties and compositions.
- Most leather alternatives are made of plastic, but more options are becoming available that reduce and even eliminate fossil-based content.
- These materials are facing mounting scrutiny as fashion faces a greenwashing reckoning, pushing brands to be more transparent about their benefits and shortcomings.

The sneakers are made from Vegea, an emerging leather alternative that has been used by brands including Ganni and H&M. It's just under 30 percent plastic, according to the small print on the product's material composition. It can only be recycled with difficulty, according to information published elsewhere on Pangaia's website.

The landscape has become so confusing that nonprofit Textile Exchange has recommended brands stop describing any materials that aren't derived from animal skins as “leather” to avoid conflating fossil-based synthetics and newer plant-based alternatives.

Even within the category there are variations between the materials and their properties. For instance, Mylo is a mix of mycelium and plant-based fibre with a water-based polyurethane finish. Ephea is pure mycelium stabilised using green chemistry.

Even more **futuristic materials** grown or fermented in labs have yet to make it to market in a meaningful way. And adding to the complexity, leather itself is often coated in plastic.

COMPLEXITY > PERSISTENCE

Long journey
from idea to innovation
and products:
material development
takes 5-15 years



TRL - Technology readiness levels



Methods mapped against the spiral showing the seven stages of innovation

Innovation cycle by Nesta

To conclude:

- No bad or good materials as such; right materials in right place
- Traditional and new materials utilized in new ways
- Efficient product and material recycling
- Non-toxic chemicals and alternative dyeing and finishing methods
- Emerging biotechnologies vs learning from past
- Local vs global
- Digitalized value chains
- Transparency of production chains
- New business opportunities and models
- Collaboration enables innovation and development

Thank you!