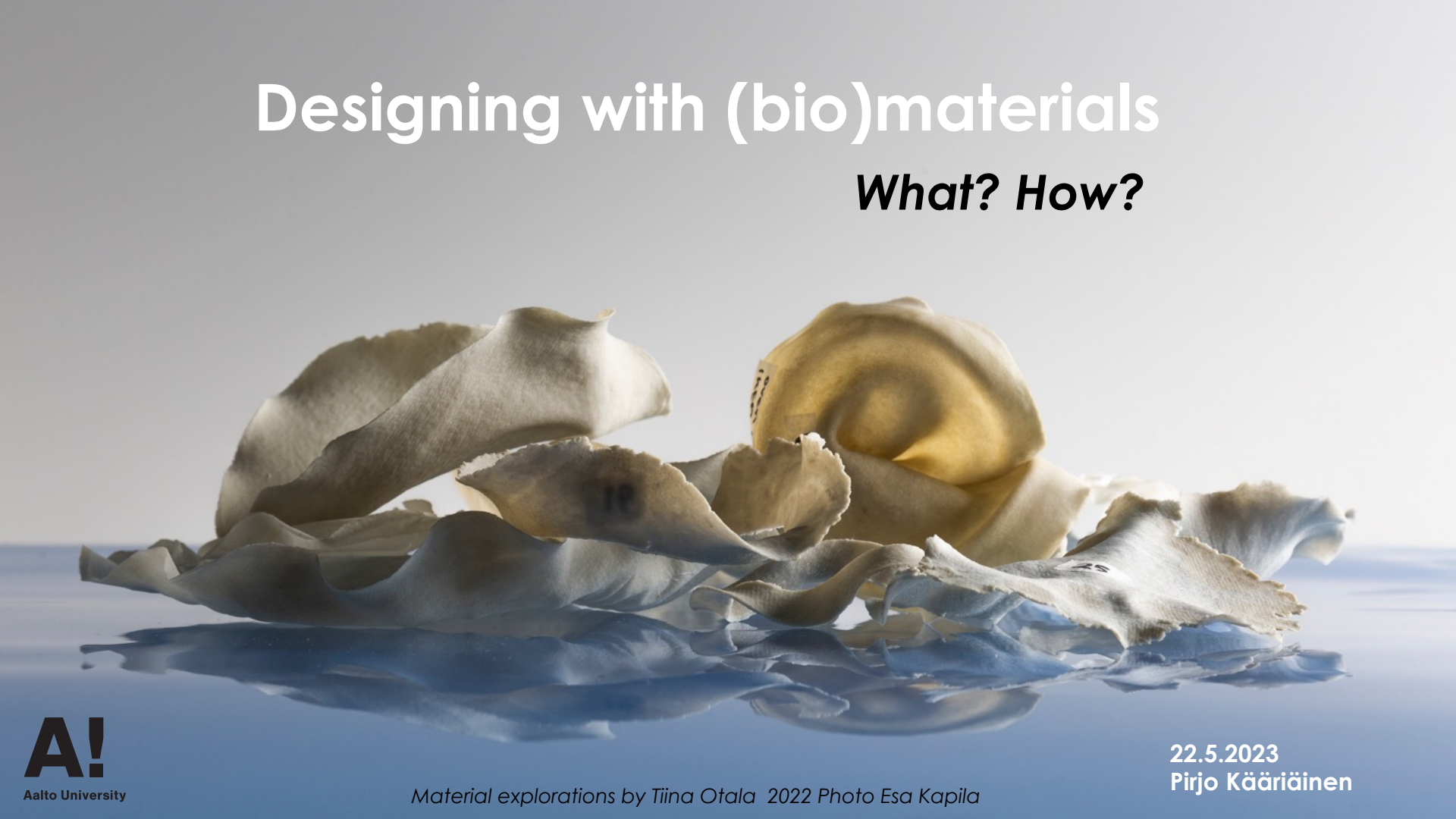
Designing with (bio)materials

What? How?



Material explorations by Tiina Otala 2022 Photo Esa Kapila

Aalto University

22.5.2023
Pirjo Kääriäinen

BIO…?

Photo: Eeva Suorlahti

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- **BIOMATERIALS** ***BIOMATERIAALIT***
- **BIO-BASED MATERIALS** ***BIOPOHJAISET MATERIAALIT***
- **RENEWABLE MATERIAL SOURCE** ***UUSIUTUVA RAAKA-AINE***
- **BIODEGRADABLE MATERIAL** ***BIOHAJOAVA MATERIAALI***
- **COMPOSTABLE MATERIAL** ***KOMPOSTOITUVA MATERIAALI***
- **RECYCLABLE MATERIAL** ***KIERRÄTETTÄVÄ MATERIAALI***
- **BIOLOGICALLY PRODUCED** ***TUOTETTU BIOLOGISESTI***
  Biology/synthetic biology *biologia/synteettinen biologia*

BIOMATERIALS *BIOMATERIAALIT:* MEANING DEPENDS ON THE CONTEXT

IN MEDICINE: Biomaterials are synthetic or natural origin materials that are used in repairs, regeneration and replacement of tissues.

Source: https://www.utu.fi/en/

LÄÄKETIETEESSÄ: Biomateriaaliksi voidaan kutsua mitä tahansa vierasta, synteettistä tai luonnollista, materiaalia jota käytetään biolääketieteessä elävän kudoksen hoitoon tai korjaamiseen.. Biomateriaalit voivat olla lasia, teflonia, titaania, erilaisia biopolymeerejä ja geelejä tai jauheita.

Lähde: https://tieteentermipankki.fi/

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Photos Eeva Suorlahti

In material research, BIOMATERIALS usually refer to BIO-BASED MATERIALS from RENEWABLE MATERIAL SOURCES (virgin, side streams, waste)

Materiaalitutkimuksessa BIOPOHJAISET MATERIAALIT tarkoittavat yleensä UUSIUTUVISTA RAAKA-AINEISTA valmistettavia materiaaleja
(neitseelliset, sivuvirrat, jäte)

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Example: Ligno-cellulosic materials

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

Trees and plants contain also lignin, hemicellulose, bark, long bast fibres, extractives for colours and natural ‘chemicals’…

Example: Using invasive species as raw materials

Experimetal materials from polluting algea (Cladophora glomerata), Laura Rusanen 2020

BIODEGRADABLE MATERIAL / BIOHAJOAVA MATERIAALI OR COMPOSTABLE MATERIAL / KOMPOSTOITUVA MATERIAALI ?

Wood pulp

Thermoformable packaging material by Huhtamäki

Sulapac packaging material

Timberfill
3D printing filament

Ioncell textile fibres
@Marimekko

Examples: Biodegradable, bio-based materials made of cellulose (and some other ingredients)

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Not only bio-based materials, also bio-based, non-toxic chemicals

Antimikrobial bandage from birch polypores, Sonja Dallyn & Linh Tong 2020

UV protection from spruce bark, Jasmin Hiekkamies 2020

Example: Using natural colours

Natural Indigo Finland & Marimekko 2021

Edith Kankkunen
& Henna Salminen
Aalto Chemarts 2020

Aleksandra Hellberg
& Jenny Hytönen
Aalto Chemarts 2019

Example: Alternative materials for art practices

Kuva Esa Kapila

Natural inks, Tessa Dean 2020

Anna Ihamuotila 2022

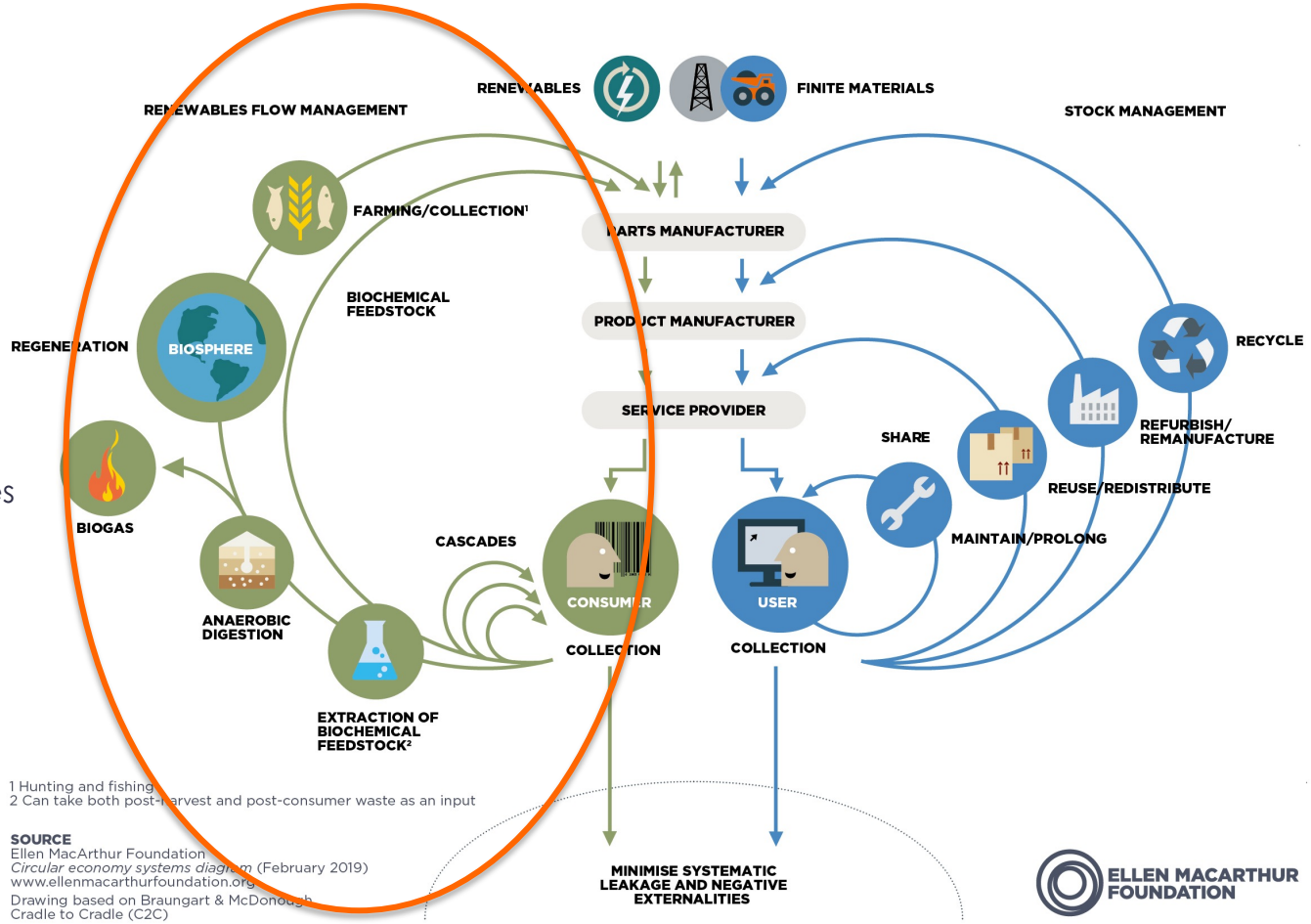
Example: Structural colour from plant-based materials

Dress by Anna Semi 2021. Structural colour expetiments Noora Yau & Konrad Klockars, structuralcolourstudio.com

RECYCLABLE MATERIALS
KIERRÄTETTÄVÄT MATERIAALIT

FOR CIRCULAR ECONOMY

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



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough
Cradle to Cradle (C2C)

ELLEN MACARTHUR FOUNDATION

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Example: From flower waste to materials

irenepurasachit.com

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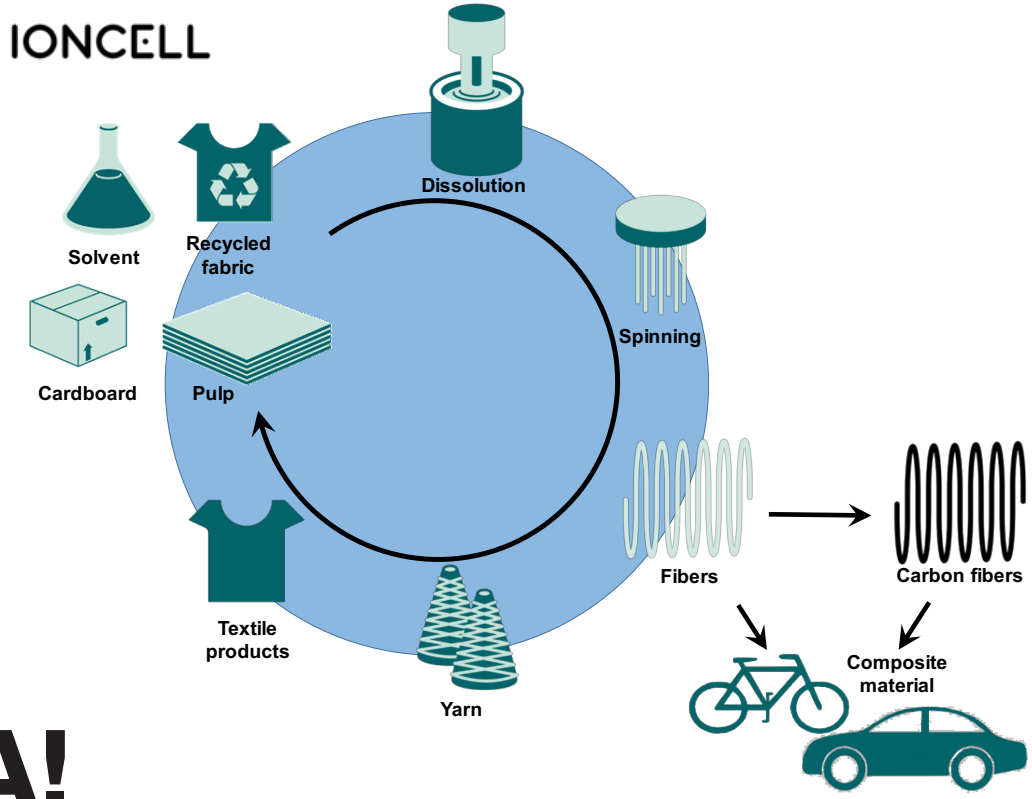
Example: Chemical recycling of cellulose-based textiles



Recycling material and colour with Ioncell technology by Eugenia Smirnova & Ioncell team CHEMARTS 2015

Upcycling newsprint into textiles with Ioncell technology by Marjaana Tanttu & Ioncell team DWoC project 2017

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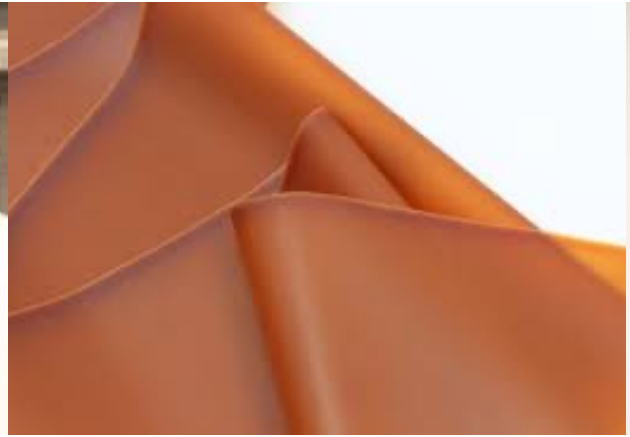
BIOLOGICALLY PRODUCED *TUOTETTU BIOLOGISESTI*

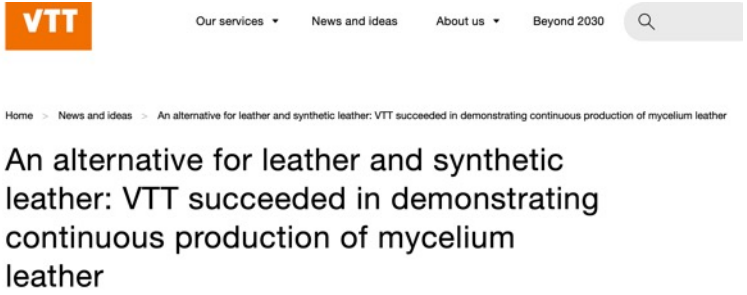
Biology/synthetic biology *biologia/synteettinen biologia*

zenaholloway.com
dianascherer.nl

biofabricate.co

Example: Materials with fungi (mycelium)





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

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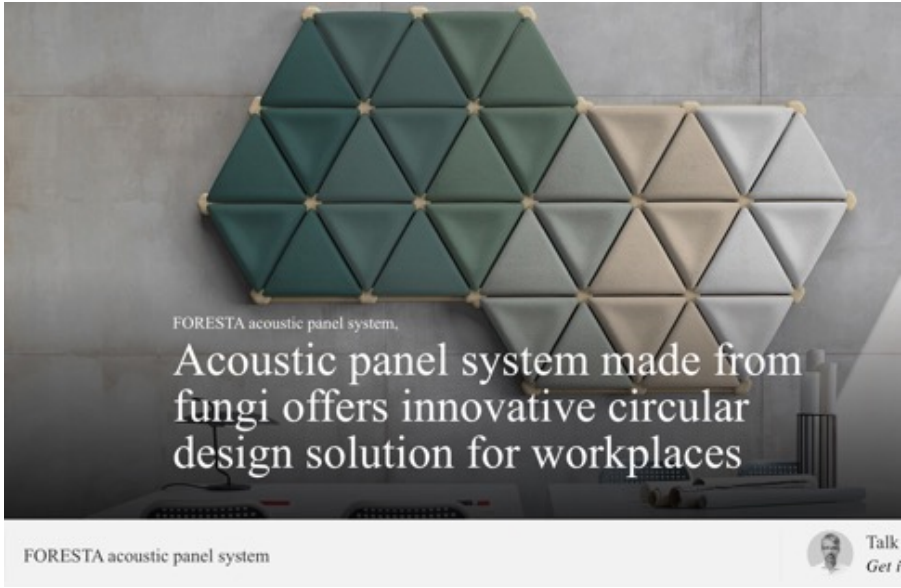
Example: Produced with of mycelium

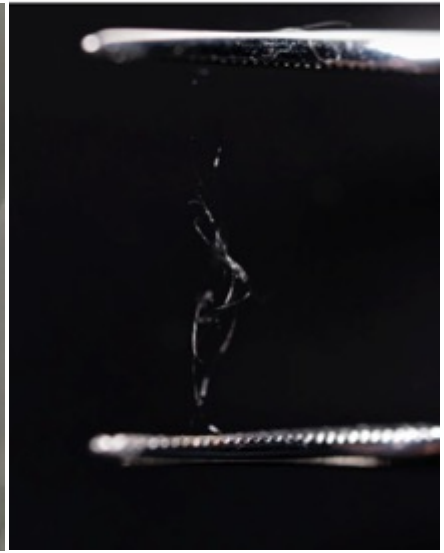
thegrowingpavilion.com

caracaracollective.com



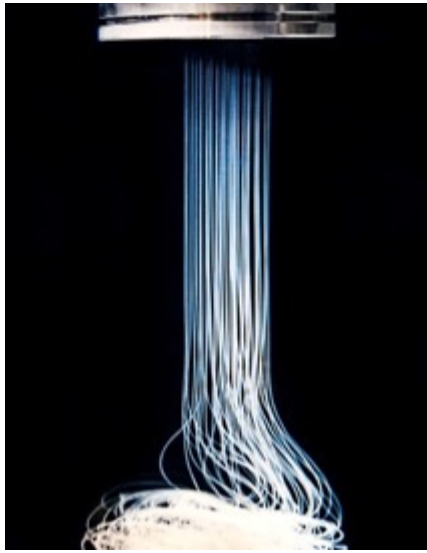
arup.com

Example: Designing new materials with synthetic biology and genetic engineering



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

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



Microsilk by Bolt Threads. U.S

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HOW?

How to be a designer in the world of new materials?

Photo: Eeva Suorlahti

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Bio-based materials are seen as one solution

1. To tackle some environmental problems such as plastic pollution, microplastics and toxic chemicals

2. Use of renewable material sources instead of non-renewables

3. Technological development is fast; new processes and production methods like synthetic biology are emerging

4. Industry renewal, for example birth of new start-up scene

5. Legislation

How wisely are we using our precious renewable raw materials today?

Light and durable nanocellulose tubes by Tiina Härkäsalmi. Bicycle by Kim-Niklas Antin & team. DWoC project 2017, photo Eeva Suorlahti

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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

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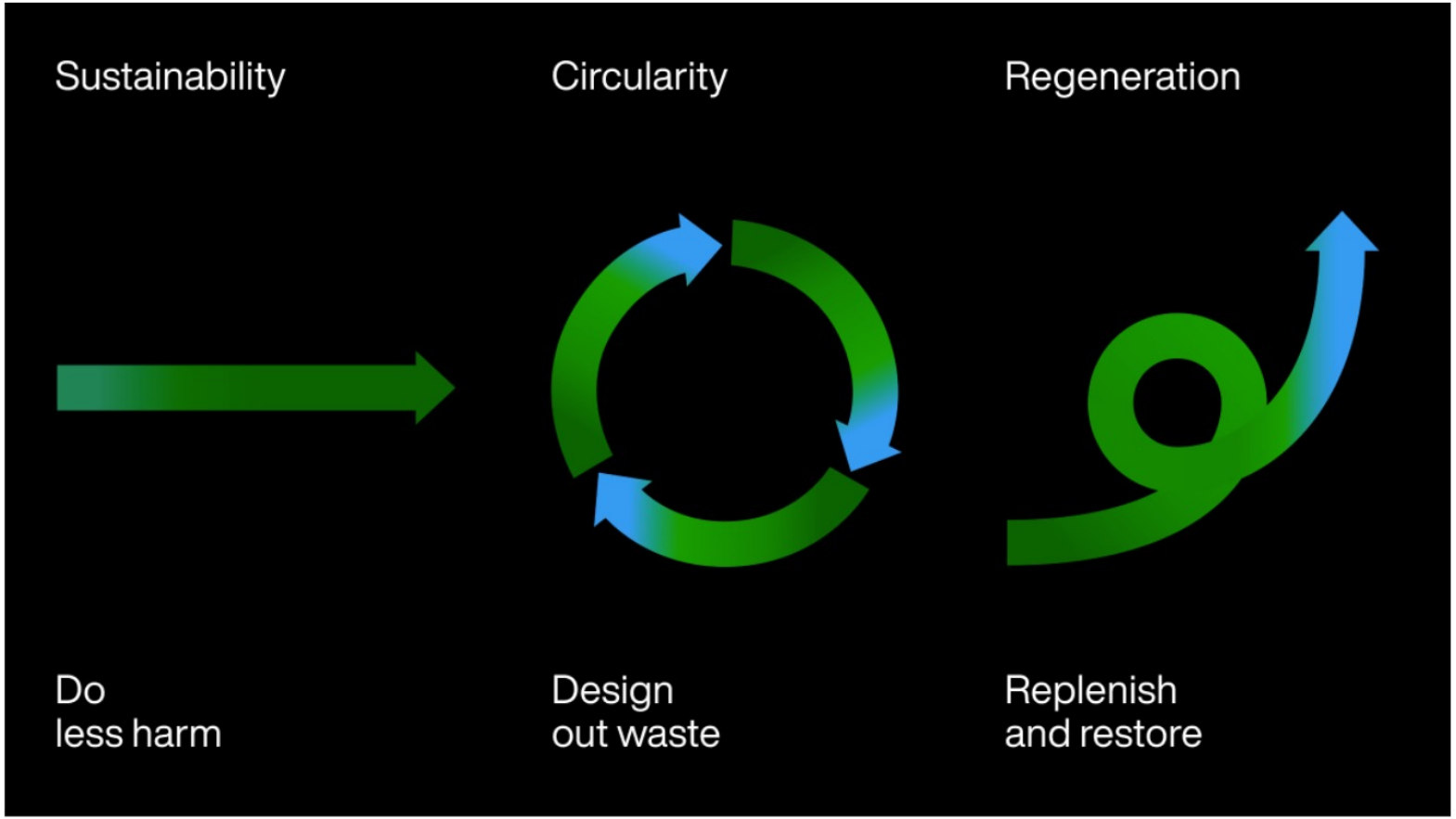
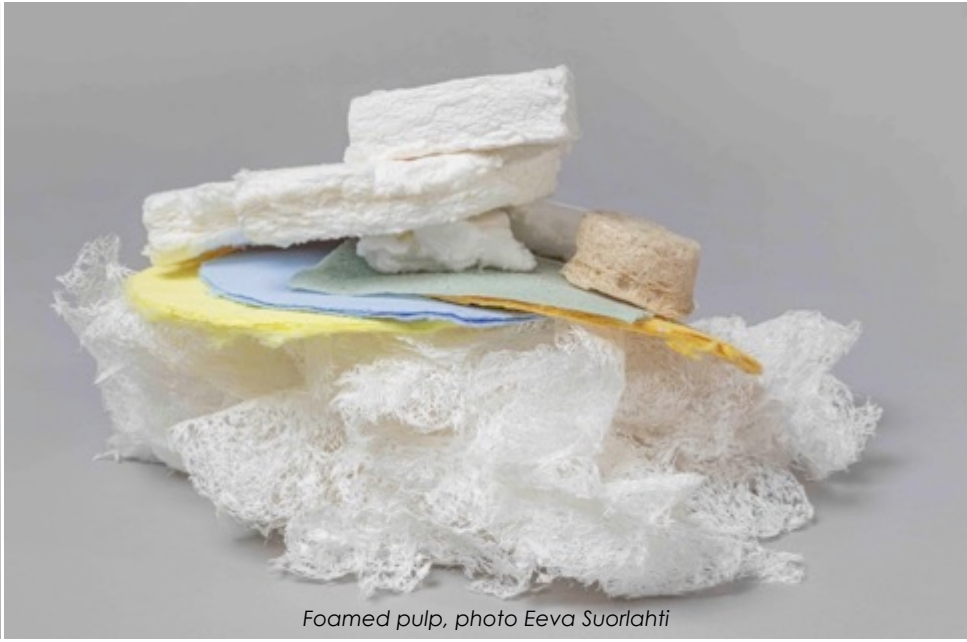


https://space10.com/regenerative-by-design/

Do less harm
Example: Replacing fossile-based raw materials with renewable ones

Bubbles with benefits
Material experiments by Satu Paavonsalo & Valentin Schwarz 2022, photo Esa Kapila



Foamed pulp, photo Eeva Suorlahti

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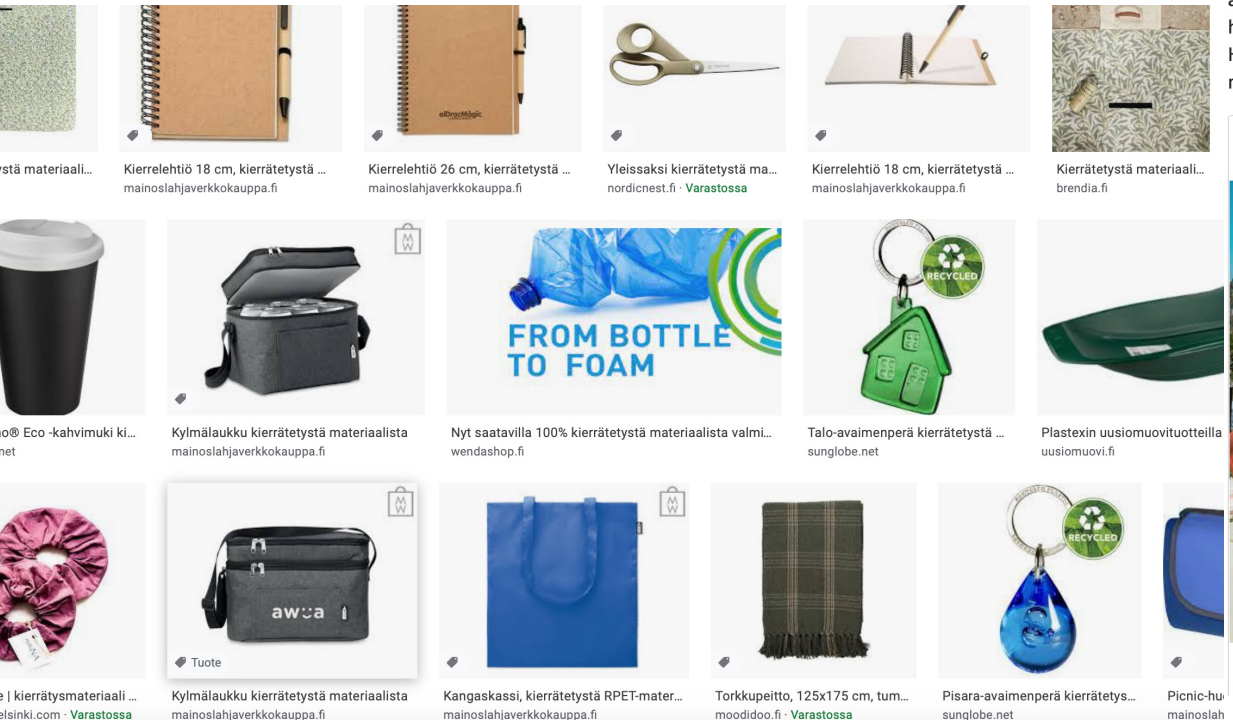
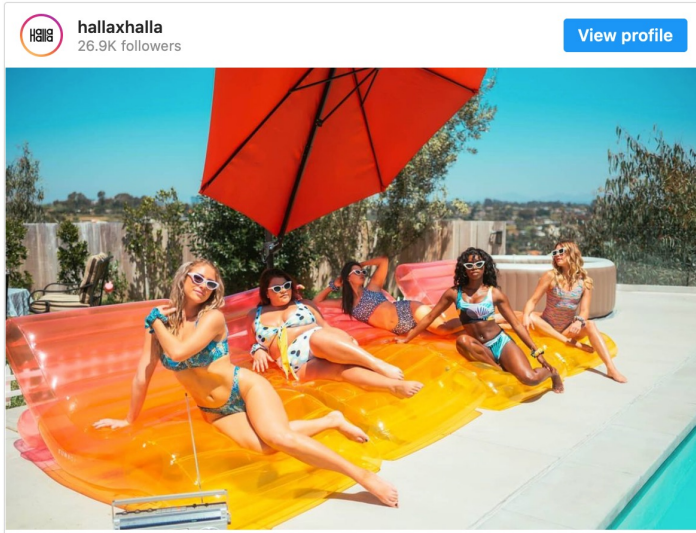
Cellulose-based materials can be soft, hard, transparent…
In most cases these materials react with moisture - and biodegrade.

Design out of Waste
Example: Upcycling plastic waste



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



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... but we also need to solve the original problem.

Replenish and restore
Example: Transforming systems towards positive ‘handprint’

IROONY

HOME PROJECT TEAM NEWS CONTACT

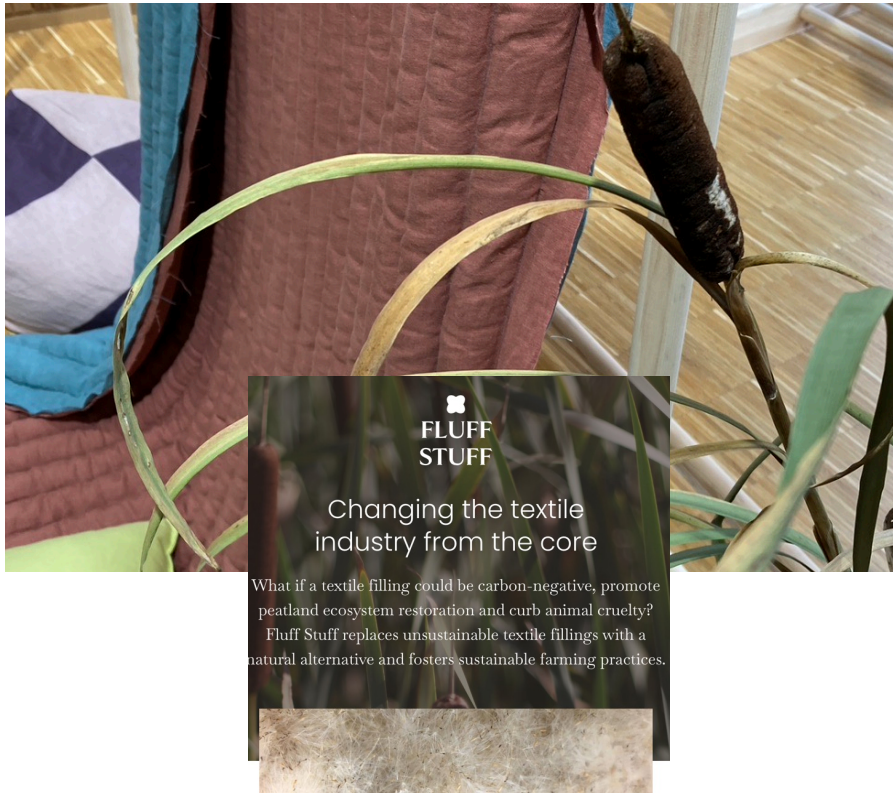
ENCOURAGE HEMP AGRICULTURE

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 requires irrigation or chemicals, preserving water both in terms of quantity and quality.



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Curiosity
Creativity
Collaboration
Communication
Critical thinking
Complexity > Persistance

Photo: Eeva Suorlahti

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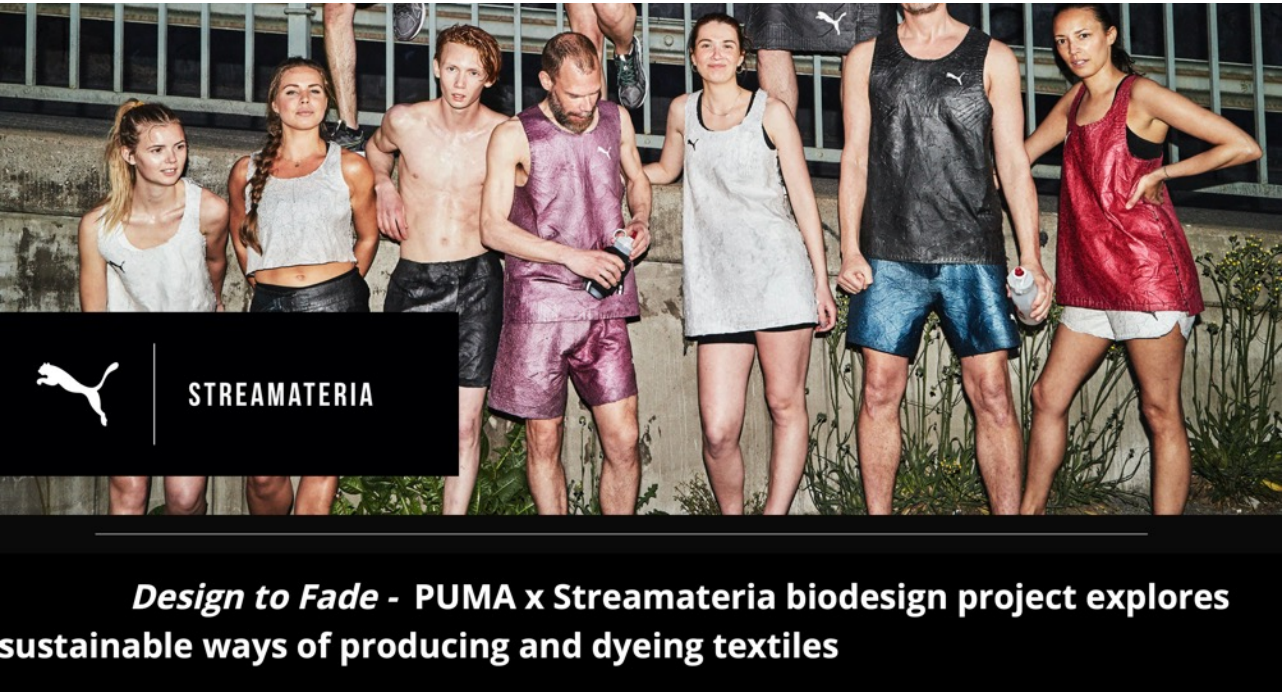
CURIOSITY

Follow material development and new technologies

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



Source: streamateria.com

CREATIVITY

Changing perspective: problems might be possibilities

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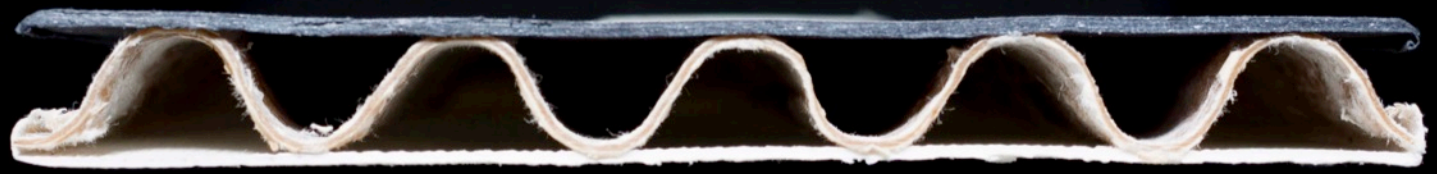
COLLABORATION

‘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



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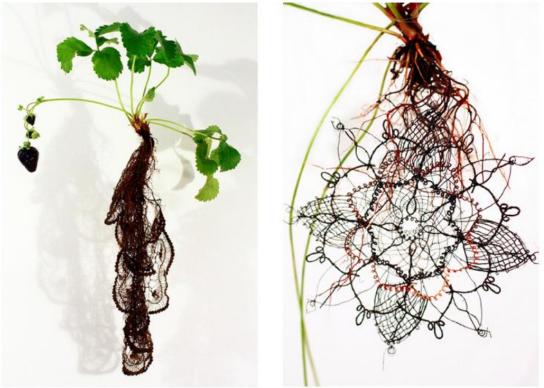
Multilayered nanocellulose sheet / Maker Tiina Härkäsalmi, DWoC project 2017, photo Eeva Suorlahti

COMMUNICATION

Biocouture jackets made of cellulose material

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



Biolace by Carole Collet

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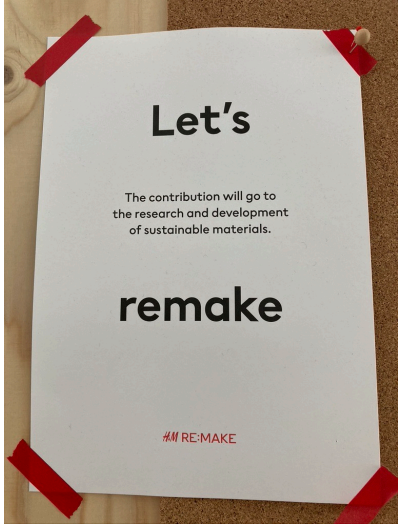

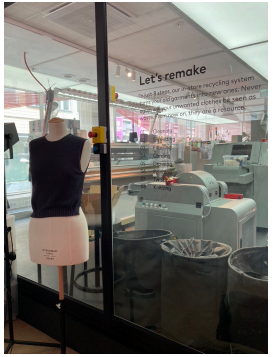

https://www2.hm.com/fi_fi/life/culture/inside-h-m/meet-the-machine-turning-old-into-new.html

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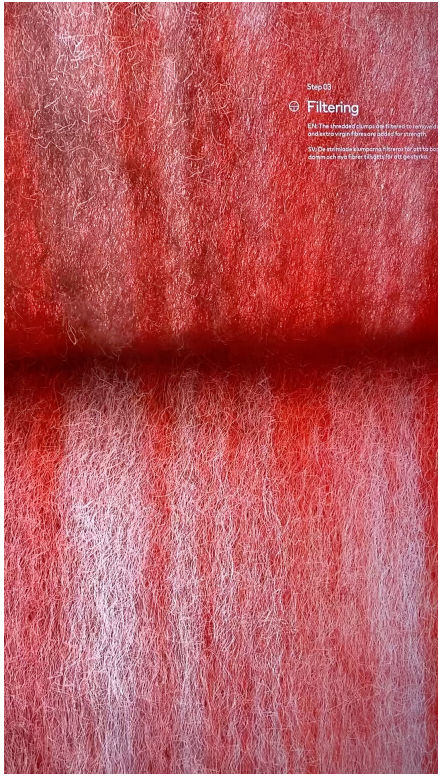
Example: H&M Communication



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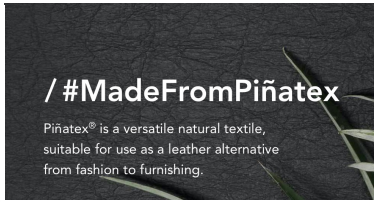
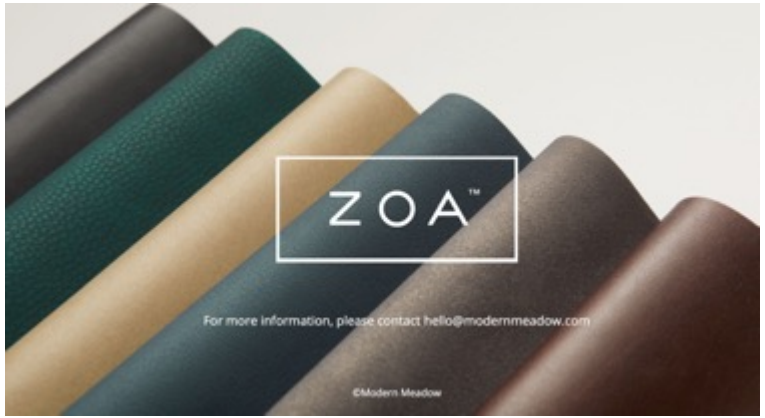
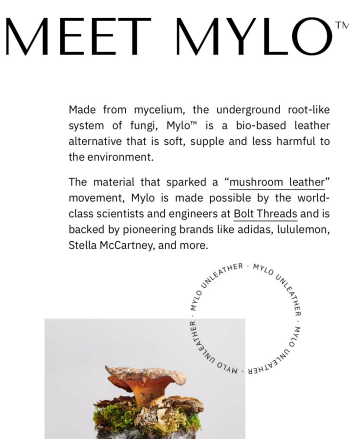
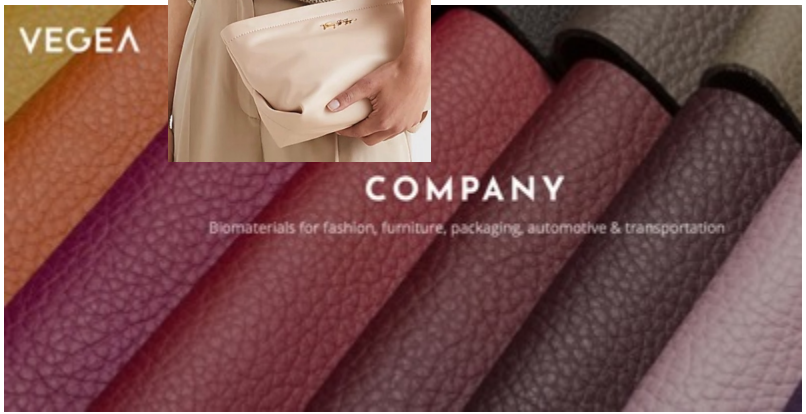
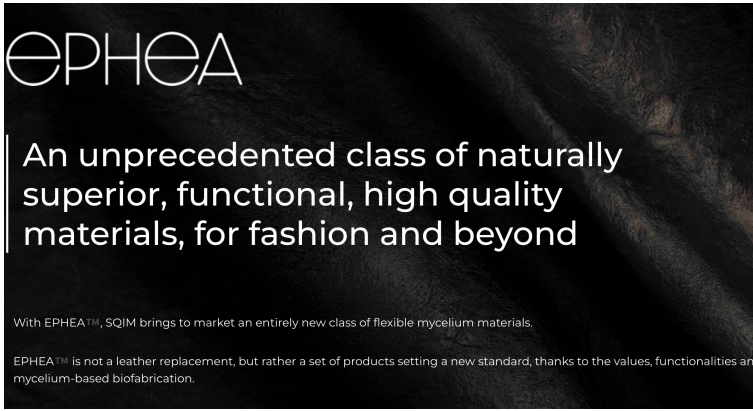




Replacing leather – but what about material sustainability?







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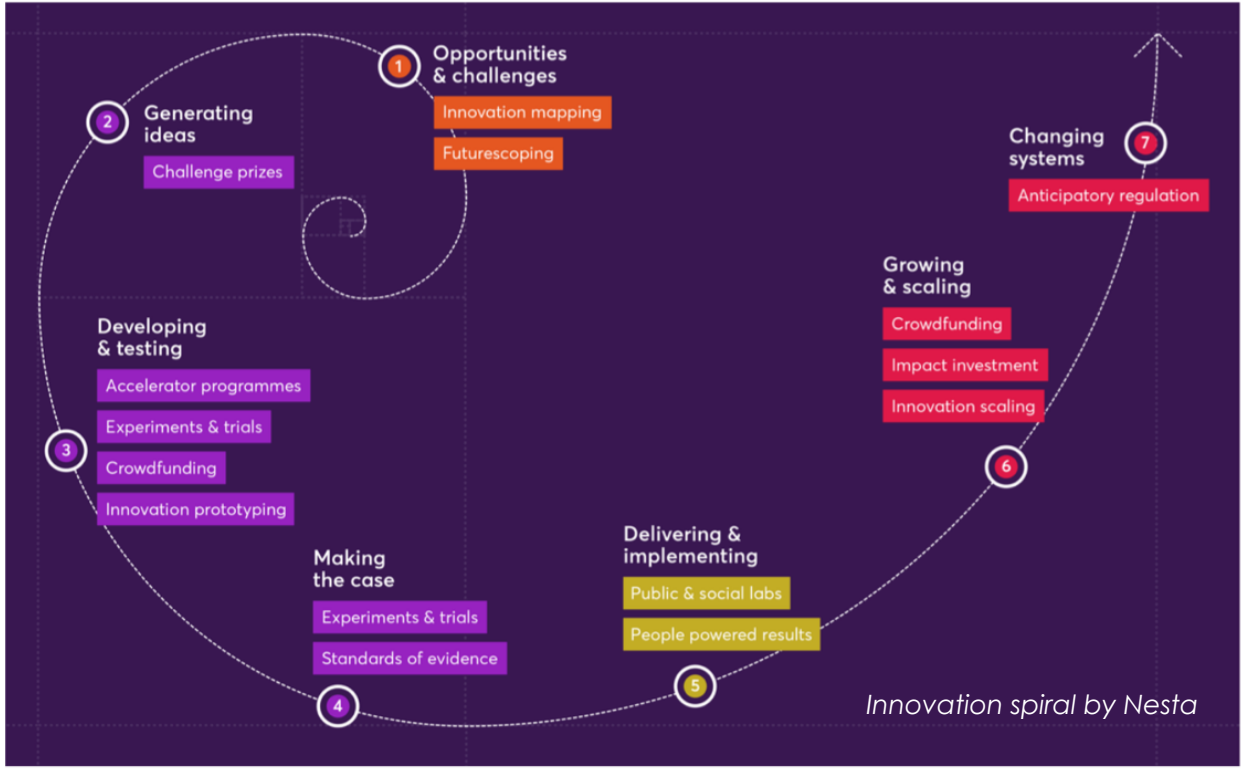
CRITICAL THINKING

COMPLEXITY > PERSISTENCE

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



Methods mapped against the spiral showing the seven stages of innovation

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Some design approaches

- Social aspects and communication to raise people's awareness of materials and their sustainable consumption habits
- Sustainable use of raw materials and natural resources and transparency of the whole production chain
- Designing for circular economy: efficient product and material recycling and creating new value for waste in circular economy
- Ideas for novel, ecologically sustainable services, processes or products – no more green washing

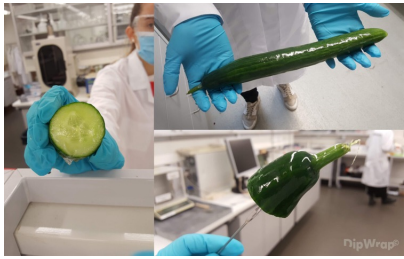
  For example for interior architecture, packaging, construction and building, textiles and fashion, edible products, cosmetics and beauty, healthcare etc.
- Exploring bio-based options for packaging, replacing fossil-based products, functional materials with non toxic finishings etc.
- Localized production - when it makes sense
- Learning from past (in good and in bad)
- Concepts for use of biological processes and synthetic biology

DipWrap

ENA NAITO, LOUISE KALLAI, EMILIA IKÄVALKO, SARI KUPIAINEN

DipWrap is a sustainable alternative to plastic shrink wrap used to protect grocery store produce. Vegetables and fruits are dipped into an aqueous solution of DipWrap consisting of agar, cellulose nanocrystal, and carnauba wax which then forms a solid film. Once peeled off, the biodegradable film can be easily disposed of.

Finalist Team + Outstanding Science Prize Winner



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THANK YOU!

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Algae hat by Nina Riutta. Photo: Mitja Harvilahti