Building New Business Ecosystem Around Textile Recycling

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- Why recycle textiles?

Circular economy transition

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Recycling of textile waste

- Technologies and innovations
- Services
- Digitalization

Building business ecosystem

- Markets
- New value networks
- Know-how

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Textile Service Life

Disposables
- One use
- Days

Short term
- <10 uses
- Weeks-months

Medium term
- Tens of uses
- Months-years

Long term
- Tens to hundreds of uses
- Decades

Clothing & Consumer Textiles
- ‘Fast’ fashion
- ‘Slow’ fashion

Nonwovens & Technical Textiles
- Hygiene products
- Medical products
- Wiping products / filters
- Most technical textiles
- Household textiles
- E.g. construction textiles

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Increased Fibre Demand

Textile Fibre Production

- Increase fibre demand (6 %/year)
- Current rates of fibre demand growth (4 %/year)
- No increase in consumption (13.3 kg/person/year)
- Fibre demand reduced use by 50 % due to recycling
- Textile fibre growth 1990-2018
Textile Raw Materials

- Need for land
  - High irrigation water use
  - Fertilizers, pesticides and herbicides
- Sustainable cotton grades reduce chemical use
- Alternative processes and recycled cotton raw materials
- Currently mainly viscose process using CS₂
  - Origin of dissolving pulp (?)

Synthetics mainly oil-based / non-renewable materials

Biobased synthetics and recycling increasing slowly

Cellulosics
- Cotton
- Celluloses

Polypropylene
- Acrylic
- Nylon
- Wool
- Polyester
Linear Model for Textiles

- Raw materials
- Fibres
- Yarns and fabrics
- Dyeing, printing, finishing
- Sewing
- Use

Chemicals e.g. dyes and additives
Water
Energy

Emissions

Use

Waste
Waste Hierarchy

Product = Non-waste

Waste

Prevention
Preparing for re-use
Recycling
Recovery
Disposal

Waste regulation:
Who can process?
Export rules?

Adopted Waste Hierachy and Textiles

- Reduction of waste by consumption/shopping habits, repairing, tuning...
- Reuse by donation, second hand stores and flee markets, renting, leasing...
- Recycling 1) as fabrics, 2) as fibres or 3) as fibre raw materials
- Other uses for fibres
- Energy / thermal recovery

Lengthening of product life

New life for materials

End of life

Consumers has large role in lengthening of product life
Service based businesses
Best option according LCA

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Adopted Waste Hierarchy and Textiles

1. Reduction of waste by consumption/shopping habits, repairing, tuning…

2. Reuse by donation, second hand stores and flea markets, renting, leasing…

3. Recycling 1) as fabrics, 2) as fibres or 3) as fibre raw materials

4. Other uses for fibres

5. Energy / thermal recovery

Upcycling possible

- Lengthening of product life
- New life for materials
- End of life

1. Fabric recycling by designers
2. Mechanical recycling
3. a) Thermal recycling
   b) Chemical recycling

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Adopted Waste Hierarchy and Textiles

Reduction of waste by consumption/shopping habits, repairing, tuning...

Reuse by donation, second hand stores and flee markets, renting, leasing...

Recycling 1) as fabrics, 2) as fibres or 3) as fibre raw materials

Other uses for fibres
- Wiping & absorbing products
- Fibres as fillers in composites
- Pyrolysis and gasification processes for producing chemicals

Energy / thermal recovery

Lengthening of product life

New life for materials

End of life
Users have a central role in creating closed loops. Circular economy is more than recycling.

Maintain the value of products and materials as high as possible for the maximum of time with the minimum environmental impact!

Use, Repair and Re-Use of Textiles

- Consumers create a demand
- Textile industry can design products that last
  - Raised consumer awareness has created markets

- Repairing
  - Big business potential - consumers may no longer have time or skills to do this

- Sharing and second-hand trading
  - New markets in e-trading and platform

- Individual consumers and small designer shops or medium size industries

(Fontell & Heikkilä, 2017)

(Heikkilä, TIFE2018, Taipei)
Textile Collecting and Sorting

- When re-use and when recycle?
- Collection systems available mainly for re-usable products
- Effectively collecting without mixing with others wastes essential for industrial recycling processes
- Recycling processing options vary depending on the fibre type
- Other factors homogeneity, cleanliness and wear and tear
- Sorting needs to be taken from manual to automated process
- Traceability and identification system for textiles would be optimal solution

EC waste regulation: Separate collection for textiles must be set-up by 2025

(Fontell & Heikkilä, 2017)
Textile-to-Textile Recycling

Fibre level recycling

Polymer level recycling

Monomer level recycling

(Fontell & Heikkilä, 2017)
Fibre Level Recycling

• Mechanical recycling typically SME industry
• Typically already applied for pre-consumer textile wastes
• Colour of the fibres remain – no additional coloration needed if sorted by colour
• Length and strength of fibres determining factors for recycling process
• Materials can be to be used for making **yarns** and **nonwovens**

Regulation related to product safety

• Better quality with 100% fibres and blends
• Hygiene and safety important

Chemical regulation e.g. REACH in EU

• Blends suitable and some impurities may be acceptable, if application allows
• Hygiene might be an issue
Polymer Level Recycling

- Recycling in polymer level is can vary from small to large size industry, chemical processes in large scale
- Different process for each polymer
- **Chemical recycling by dissolution** and **thermal recycling by melting**
  - May be used to separate blends
  - Removes contaminants (hygiene not a big issue)
  - Might be affected by some contaminants (e.g. metals)
  - Currently merging & development stage for cotton
  - Technology available for acrylic fibres
  - Polymer properties - chain length and its distribution - critical
  - Thermal processes available *and/or demonstrated* for polyester, polyamide, polyethylene and polypropylene
Monomer Level Recycling

- Recycling in monomer level is process industry which typically needs to be operated in large scale to be economical
- Different process for each polymer
- **Chemical recycling by re-polymerization** for synthetic fibres
  - Removes contaminants (hygiene not a big issue)
  - Might be affected by some contaminants (e.g. metals)
  - Industrial processes existing for polyester and polyamide-6 (and -66)
  - Challenge is in process economics, but process developed might change that in the future
  - Also LCA of processing needs to be considered
Textiles from Recycled Fibres

- Brands are interested in recycled textiles and fibres e.g. because they
  - Anticipate challenges and possible price fluctuations in the virgin materials (such as cotton) supply in the longer term, or
  - Want to offer more sustainable choices to the increasingly conscious consumers.

- Existing value chain
  - The current textile technologies can handle recycled materials with some adjustments
    - Rotor spinning is more suited to shortened, recycled fibres than ring-spinning
    - Mixing post-consumer recycled fibres with virgin materials ease processing
Towards Circular Ecosystem

Textile reuse loops should/could be strengthened → business opportunities for forerunner companies

Brands interested in more sustainable and recycled materials, but supply still limited

Rising consumer awareness helps in creation and increase of markets

Multidisciplinary skills needed - digitalization and service based business models essential

Missing pieces of the value chain needs to be developed:

★ Collecting system
★ Sorting system
★ Upscaling of recycling technologies

Regulation needs to be updated (waste, chemical, etc)

Public incentives and financial support could fasten transition to circular economy, and in building of new ecosystems!
Building Ecosystem in Finland

The Relooping Fashion Initiative
2015-2017
Tekes – The Finnish Funding Agency for Innovations

Telaketju
The collecting, sorting and recycle chain for textiles
2017-2018
Tekes & Ministry of Environment
2018 →
Business Finland & Ministry of Economic Affairs and Employment
The Relooping Fashion Initiative

- Piloting of closed loop recycling of cotton
- Consumer studies
- Modelling of the ecosystem

https://www.youtube.com/watch?v=xa-E2Re3b

www.reloopingfashion.org
Closed Loop Recycling of Cotton

1. Used clothes are collected from return

2. Material is sorted and cotton pre-processed

3. Cotton is dissolved using our unique technology

4. Solution is spun into fibres to be made into cloth

5. Clothing retailers produce and sell the clothes

6. Consumers can send back old clothes using recyclable packaging

www.reloopingfashion.org
Telaketju - Ecosystem Building

The end of the uncontrollable export to the third world countries

LOGISTICS

GATHERING

SORTING

REFINING

FINAL PRODUCT

EXPLOITATION

energy

recycle as material

product in it's original purpose

robo-tics

The increase of textile value

mecha-nical

chemical

raw material

reuse

industry

Research and innovations

Domestic know-how

export

New employment

New businesses

Circular economy

industry surplus

consumers

The end of

Multi-disciplinary cooperation

work in 2018, Taipei

Telaketju

www.telaketju.fi
Telaketju - Ecosystem Building
Telaketju - Ecosystem Building

**Ympäristöministeriö**
Miljöministeriet
Ministry of the Environment

- **Topics:** Collecting, sorting and pre-processing
- **Participants:** Municipal waste management and recycling organizations, public participants, as well as charities.

**Ministry of Economic Affairs and Employment of Finland**

- **Topics:** Investments and markets & business planning
- **Beneficiary:** Municipal waste management organization in Southwest Finland

**Tekes**

- **Topics:** R&D for processes, products, services
- **Participants:** Companies, Research Institutes, Academia

**Business Finland**

**www.telaketju.fi**
Circular economy is coming - need for recycling, but also for lengthening product life

This changes business value chains and networks to build missing pieces of the puzzles

Change is providing new business opportunities to e.g. in services and digitalization

New technologies and innovations also needed

Consumers attitudes are starting to favour circular values

Transformation has already started – forerunners already involved

Public incentives and financial support can have significant effect on this development
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A brighter future is created through science-based innovations.

Thank you for your attention!