



mistra
future
fashion

annual
report
2017

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know-how for enabling systemic change

During 2017 with the support from Mistra Future Fashion four doctoral theses were finalized, each and everyone adding valuable new knowledge across the ecosystem for clothes; on 'how to design', 'how to accurately assess footprint', 'how to bring about organizational changes' and 'how to advance in textile to textile recycling'. Eight academic articles and eight reports were published. Innovative ground breaking solution for textile to textile recycling of polycotton fiber blends like the 'Blend Re:wind' process were released, and Design Strategies were put in practice via the industry imbedded Circular Design Speed project at the residence of Filippa K.

39 research tasks were active, engaging 46 research scientists in collaboration with a pool of 50 industry partners. Results were activated and disseminated via partnerships with international fashion industry networks like Fashion for Good, Ellen MacArthur Foundation and Sustainable Apparel Coalition.

redesigning a system takes it start in understanding the lifecycle of a product, via so called 'Life Cycle Assessments', LCA.

What does a new system look like and what type of mindset do we need in the future – these are the questions that Mistra Future Fashion addresses. Redesigning a system takes it start in understanding the lifecycle of a product, via so called 'Life Cycle Assessments', LCA studies. Historical lack of available data meant that analyses have

been tough to perform, leading to incomplete generalizations and myths. Partly to address this, our researcher Dr. Sandra Roos at Swerea IVF completed her doctoral studies in 2017 by providing more comprehensive LCA of fashion, including for first time its chemical impact. Besides gaining better understanding, the data can support thousands of practitioners in their decision making via global LCA databases.

New definitions of 'fast' and 'slow' fashion are needed in a circular system. The team at University of the Arts London explore 'Speeds' in relation to materials and product use, guided by LCA data. For example - 'Slow' fashion; how services like repair, re-selling, re-design and sharing can activate garments to its full potential in use. On the other end of the spectrum, fast fashion, the concept 'ultra fast forward' tests fast lifecycle in a sustainable way. Bio-based materials like paper textiles (that feels and act like textiles) are explored together with RISE for allowing fast sustainable production and consumption. By limiting times of use to only three, no washing is needed and can be safely disposed in a recycling system. A concept not relevant for all types of products, but for certain usage needs.

new definitions of 'fast' and 'slow' fashion are needed in a circular system.

LCA reveals the high environmental footprint that lies in the production steps today. Ongoing advancements of technology will address these issues as well as providing

smarter, leaner and more sustainable processes. For example, by exchanging traditional cutting techniques to ultra-sound technique microplastic shedding from fabrics can be minimized, which is presented in the study on Microplastic shedding conducted by Swerea IVF.

Using a t-shirt an average of three times longer the footprint would decrease by 68%, why users' most sustainable action is to prolong the lifetime of existing clothes. Consumer studies by Copenhagen Business School (CBS) confirm that even if well-being is a motivator for choosing sustainable fashion, consumers argue that sustainable alternatives are hard to find. Consequently they need to grasp the role of new business models, like clothing library, leasing and second-hand. Thus, understanding the underlying stimuli of consumption plays an important role for new business services, especially when aiming for a shift of 'Ownership' to 'Access'. Consumer insights on habits of fashion consumption and sustainability, such as gained from CBS' studies, serve as a base when designing more efficient narratives for nudging consumers.

Every year the volume of approximately 100 million tons fibers are produced. The need to find alternative sustainable sources in large volumes is an ever urgent issue. Perhaps new sources of fibers in combination with better utilization of textile waste could be a potential future solution. In 2017 our six year long 'PolyCotton' project revealed breakthrough results on cotton polyester blend recycling, developed by Chalmers, RISE and forest company Södra. It was named the 'blend Re:wind' process. This was enabled thanks to dedicated doctoral studies by Dr. Anna Palme on characteristics of fibers from used cotton sheets. Globally there are

overall a few promising processes emerging, targeting different fibers and mixes. Hopefully within a 10 years' time frame the textile recycling industry has fundamentally changed.

Efficient policies play an important role for system progression. During 2017 the teams at IVL, IIIIE and PlanMiljö investigate policies for new business models, extended producer responsibility (EPR) and Refunded Virgin Payments (RVP). The aim were to shed light on potential impacts and act as guidance to fashion industry stakeholders as well as governmental bodies in their decision making process.

today's textile to textile recycling holds complex challenges but luckily promising recycling processes are on its way.

The new system sighted, is ideally guided by LCA data, user centered with many available options; designed and developed within sustainable operational frames. The industry stand to gain in terms of business opportunities by supporting the Users' multispeed wardrobes with a mix of short-life and long-life garments, new and second-hand, rented or borrowed. This, so that we as citizens of this planet can enjoy fashion in an engaging and positive way.



Sigrid Barnekow
Program Director



Dr. Åsa Östlund
Deputy Program Director

research for sustainable fashion

a research program with a vision of enabling systemic change leading to a sustainable fashion industry and society

sustainable fashion

The program focuses on environmental and climate effects caused by global fashion sector and the changes required for future sustainable operations. The research **applies the principles of circular economy** and is structured around four themes – **Design, Supply Chain, User and Recycling**.

unique system perspective

The program holds a holistic system approach for the fashion value chain, from fiber to recycling, and how it needs to change in order to become more circular. The research is **cross-disciplinary**, allowing comprehensive analyses and insights. New knowledge is verified in a holistic context, **ensuring sustainability also from a system perspective**.

consortium based

The program research rests on engagement with its consortium: research institutes, universities, government agencies, non-governmental organizations as well as companies within the textile value chain; from forestry, pulping and textile manufacturing to fashion retail and recycling. **The partners set the research scope**, participate in the research with intelligence, resources and materials, and agitate for implementation.

results leading to global competitiveness

Expected results are scientific knowledge and novel solutions that **enable positive change** in the fashion sector in terms of its environmental performance and its global competitiveness.

platform for sustainable fashion

The initiator and the primary funding organization is **MISTRA, the Swedish Foundation for Strategic Environmental Research**, which provides a SEK 80 million grant. An additional SEK 30 million is co-financed by in-kind contributions from industry partners. The program is now in its second phase of the total program period of 8 years, 2011-2019.

expected results are
scientific knowledge and
novel solutions

why

The global fashion industry faces multiple challenges when meeting modern requirements for sustainability, traceability and transparency. **Today's fashion industry means severe environmental impacts** from production, hazardous substances in garments, mass consumption and generation of large volumes of textile waste. **Majority of today's fiber production is unsustainable**, either as conventional cotton that requires high amounts of pesticides and water in places where water is scarce or synthetic fibers such as polyester which is made of our planet's fossil resources. The issue is also

about providing the high volumes required. A challenge that will get worse with the continued global population growth. An annual volume of 100 million metric tons is estimated to be needed by 2020 (Eichinger, 2012), and very few nascent sustainable alternatives can meet those demands. However, new alternative **fibers sources is not enough since 70% of a garments climate impact stems from the total production phase**, such as fiber production, yarn production, weaving, dyeing, finishing, sewing, surface treatments, etc, due to its energy, water and chemical usage.

New sustainable fibers in old production processes challenges the output as sustainable products. The overarching issue that needs to be addressed is the imbalance in efforts needed for production vs usage. In general there is **high environmental impact required for a short user phase**. Furthermore, modern consumption habits generate massive textile overload in the market and ultimately also problems with waste. This is result of the linear economy model, where 'take, make, waste' represents a broken design right from start.

vision: enabling a systemic change of the fashion industry

how

A **new model** is required in order to utilize the resources in the most efficient and sustainable way, and to minimize (and hopefully eliminate) waste. **Policies are required that prompt the development of new market and business models allowing consumer behavior to be changed**. With the aid of information flow and digital technology developments, new consumer habits and demands may appear, along with **advances in sustainable production processes** and techniques, which also assume less geographical dependence.

We need textile **fibers that are sustainable, but comparable in quality and price to existing**, non-sustainable fibers. A circular model will involve more **advanced design processes incorporating sustainability impact procedures right from the design phase** – procedures that are based on intended usage and duration of use, which **ensure optimum usage via re-use and which enable separation and the regeneration of new fibers at the point of disposal**.

We hope to see a **future with recycled fibers from textile waste**, new sustainable production techniques and new consumption habits leading **towards new services such as leasing, re-design and borrowing**, which will encourage **flourishing new business in re-use, collection, sorting and recycling**. This will mean available alternatives and enable more sustainable actions.



4 recycling

We develop knowledge and new processes in recycling methods and the impact of post-consumer textiles in order to provide guidance on necessary steps to enable sustainable textile recycling.



3 user

We make recommendations on how to encourage sustainable consumer behavior and to increase user engagement in sustainable consumption. Specifically, we develop recommendations for increasing services for extending the life of garments, reuse, and second-hand consumption.

1 design

We explore and evaluate the environmental potential of the design and user potential of short-life vs long-life garments, and the full spectrum in between, to find the most suitable choices for a circular textile economy for different types of garments and uses. Expected outputs will be recommendations, guidelines and tools for how to design for resource circularity.


2 supply





We identify the necessary actions in textile and garment supply chains to enable circular economy guidelines for governance on how to transition to and sustain a circular textile supply chain.





our partners





| | research partners | involved in theme | researchers | output |
|---|--|---------------------------------------|---|--|
|  | BOKU | Recycling | Doris Ribitsch | Chemical engineering Textile fibre recycling |
|  | Chalmers University of Technology | Design Supply Recycling | Greg Peters Anna Palme Rickard Arvidsson | LCA Chemistry Fiber prototypes |
|  | Copenhagen Business School | Design Supply User | Wencke Gwodz Esben R G Pedersen Kirsti Reitan Andersen Kristian S Nielsen | Consumer behaviour Business models Local production |
|  | IVL, Swedish Environmental Research Institute | User Recycling Supply | Maria Elander Hanna Ljungkvist | Policies |
|  | KTH, Royal Institute of Technology | Recycling | Per-Olof Syrén Marie Syrén | Chemical engineering Textile fibre recycling |
|  | More Research | Supply Recycling | Björn Källman Hanna Rammsy | Viscose pilot production |
|  | PlanMiljø | Supply User | David Watson Anja Charlotte Gylling Philip Thörn | Policies Business models |
|  | re:newcell | Recycling | Christofer Lindgren Henrik Norlin | Chemical engineering Textile fibre recycling |
|  | RISE | Design Supply User Recycling | Hanna de la Motte Gustav Sandin Albertsson Helena Wedin Finn Englund Åsa Östlund Hjalmar Granberg Tatjana Karpenja Siv Lindberg | Nonwoven biobased materials Process analysis Consumer perception LCA Cellulose Chemistry Fiber prototypes Recycling feasibility Auto sorting |
|  | Stockholm School of Economics | User | Susanne Sweet Tina Sendlehofer | Market Supply chain strategy Business models |
|  | Stockholm University | User | Claudia Rademaker | Consumer behaviour Business models |
|  | Swerea IVF | Design Supply Recycling | Sandra Roos Hans Lennart Norrblom Zengwei Guo Anna Rúna Kristinsdóttir Christina Jönsson Oscar Levenstam Arturin Anne-Charlotte Hanning Desiré Rex | LCA Microplastics Chemistry LCA Fiber benchmark |
|  | The International Institute for Industrial Environmental Economics | User Supply | Naoko Tojo Åke Thidell | Policies Recommendations |
|  | The Swedish School of Textiles | Design Recycling | Ellinor Niit | Design Textile Technology |
|  | University of the Arts London | Design Recycling | Kate Goldsworthy Rebecca Earley Kay Politowicz Clara Vuletich | Strategic design Prototypes Design Guidelines |



a consortium with partners who share the program vision and actively contribute to the program goal







































international network partnerships:



The Mistra Future Fashion program is a consortium whose partners stand behind the program vision and actively contribute to achieving the program vision and goals.

The program covers a broad range of expertise and involves the most established **experts and progressive leaders within their respective research fields**. The research is organized around four themes and involves researcher partners from Sweden, Denmark, Austria and the United Kingdom.

The industry partners involved are a mix of relevant stakeholders from across the value chain such as producers, designers, retailers, waste managers and NGOs.

The consortium has two levels of industry partnership; Stakeholder partners, and Advisory Stakeholder partners.

Stakeholder partners include in-depth involvement in research tasks with inputs such as expertise, information-sharing, resources, equipment and materials.

Advisory Stakeholder partners actively follow research progress and provide input on shaping the agenda.

“We deeply appreciate the holistic view of Mistra Future Fashion considering all parts of the textile value chain from designer to user and even beyond. Close collaboration is paramount when it comes to changing a whole industry.

With the Refibra™ fibre, Lenzing AG has taken a big step towards closing the loop in the textile industry. The research conducted and results obtained within Mistra Future Fashion help us to improve by better understanding and getting different views on the challenges ahead to arrive at sustainable fashion.”

- Dr. Christian Weilach
Global R&D, Pulp and Biorefinery Technology
Lenzing Aktiengesellschaft



“Fashion for Good is the global platform for innovation, made possible through collaboration and community. Mistra Future Fashion is a key partner of ours and we highly value their focus on innovation and their approach towards systems change. In 2017 Mistra Future Fashion’s expertise on chemical recycling was hugely beneficial in helping us evaluate innovations that had been invited to join our Scaling Programme. The Mistra Future Fashion team combines a strong academic background with a systemic view - enabling the industry to foster innovation in the fashion supply chain.”

- Katrin Ley
Managing Director
Fashion For Good

new knowledge presented 2017

design

theme 1: How to design for circular economy?

Designing for the circular economy requires a proactive and embedded design approach, where materials are designed with end-of-life recovery in mind at the outset.

To enable fully joined cycles of material use is the ultimate aim, but the 'speed' of the cycle also needs to be considered in order to make informed and appropriate design choices. This theme seeks to explore the polarization of the fashion system in order to gain insights into these design decisions.



Dr. Kate Goldsworthy,
University of the Arts London



Prof. Rebecca Earley,
University of the Arts London

new understanding of speed towards circular design

Understanding the lifecycle of a product is key in creating a sustainable industry; thus the future is dependent on a **new definition of 'fast' and 'slow' fashion**. How do we design materials and products that work with the current models for fashion consumption, how can this be measured and then communicated to designers? In order to answer these questions the concepts of 'short-life fashion' and 'long-life fashion' is explored in theme 1.

Focusing on 'speed of cycle', the aim is to better understand the challenges cycle of speed may bring to design and to prepare for the subsequent action research phase. The research includes **development of design research prototypes and new materials**. The aim is to develop the discourse from fast and slow pure and simple, to a level where multiple, proportionate speeds can be both understood, tested via LCA and ultimately engineered to improve the circular efficiency of a product.

The basis of the project emerged from Textile Toolbox project during phase 1, where researchers from UAL first produced prototypes exploring circular speeds; 'asap paper', 'digital seamsdress' and 'fast refashion'. In phase two these designs have been further developed into '**ultra fast forward**' and '**super slow**' concepts.

academic articles on
understanding speed and
circular design:

Goldsworthy K (2017) The Speedcycle: a design-led framework for fast and slow fashion lifecycles EAD12. Rome April 2017. The Design Journal. Special Issue, 2018.

Earley R (2017) Designing Fast & Slow. Exploring fashion textile product lifecycle speeds with industry designers. EAD12, Rome April 2017. The Design Journal. Special Issue, 2018.

In 2017 Clara Vuletich published her doctoral thesis '**Transitionary Textiles**' at University of the Arts London. The study explore new practices for fashion textile designers in the transition to Design for Social Equity in the fashion textile industry. The thesis was also a part of the TED's TEN project, presented in Mistra Future Fashion phase 1.

Vuletich C (2015) Transitionary Textiles - a craft-based journey of textile design practice towards new values and roles for a sustainable fashion industry. University of the Arts London. Published in 2017.

ultra fast forward new materials for fashion design

Paper-textile for the '**ultra fast forward**' fashion design concept is developed collaboratively by researchers Kay Politowicz and Kate Goldsworthy from UAL with Hjalmar Granberg from RISE.

Wearable 'paper': the inexpensive 21st-century fabric has an intentionally short lifespan and can be recycled or industrially composted. Made from unbleached wood pulp and other bio-based materials, the non-woven paper is finished using natural dyes, laser surfacing, and efficient ultrasonic construction. Energy and chemicals are reduced at every stage.

With automated production, consumers could customise each garment's colour, pattern and shape. Acknowledging that disposable fashion forms part of most wardrobes, this new material offers a more sustainable approach to fast fashion.

In 2018 the final prototypes from the 'ultra fast forward' study made in paper-textile will be on display at the V&A museum in London during the exhibition 'Fashion from Nature', opening on the 21st of April.



"I find it really inspiring to work in the Mistra Future Fashion project as it involves a close collaboration with experts from many disciplines. By combining research in design, human perception, recycling, materials and production processes, we can quickly boil down to the essential questions that help feeding new ideas and speeds up the progress.

One such example comes from the discussion with the designers at UAL. When it became evident that a cream colour is as desirable as the pure it gave us a new starting point for textile design. This made us try brown unbleached pulp in the recipe of the textile-like paper, which then combined the gain from a good base colour and reduced chemicals in the production.

Another example comes from the discussion with the recycling experts, where it became evident that a monomaterial is usually simpler to handle than a composite. This made us rethink our mixture of biobased sources for the textile-like paper, significantly reducing the thermoplastic component, which resulted in a different textile-like paper that perhaps could be recycled in the existing bins for paper or board."

- Dr. Hjalmar Granberg
RISE

"We want to be able to enjoy fashion and update our wardrobes in a conscious way. That is what the project 'Circular Design Speeds' is about. We will develop circular garments where all environmental impacts and aspects during a full life cycle are taken into account

To have access to and by guided by the latest research during the development process is fantastic. It contributes with insights, new learnings and the possibility to try out new tools and frameworks."

– Elin Larsson
Sustainability Director
Filippa K



Circular Design Speeds

industry embedded pilot study redefining 'fast' & 'slow'

In May of 2017 Mistra Future Fashion and Filippa K announced the project 'Circular Design Speeds', led by Prof. Rebecca Earley and Dr. Kate Goldsworthy from University of the Arts London. The two year project includes researching, developing and testing of **new strategic design for 100% circular fashion garments**. The idea is to implement insights from the research program into an existing fashion industry context, **focusing on speed of use and maximizing fabric value retention in products**.

The Circular Design Speeds study consciously consider and optimize the life of fabric, production processes and business models through a holistic design process. This may be through extending the life of an existing garment by design interventions over time, or

through the development of hyper-recyclable short-life products, enabling efficient recovery of virgin fabrics over multiple lifetimes. Based on this study, **commercial garments will be available at selected Filippa K's retailers in late 2018**.

The greater vision is to generate meaningful and industry-aligned insights towards a systemic change in the fashion industry. In an effort to consider the entire system, **the project also includes additional researchers from the Supply Chain, User and Recycling themes reviewing the scientific basis of the ideas, operational logistics and business case**. For the first time design decisions will be made with quantified scientific 'Life Cycle Assessment' data, utilizing the database created by Sandra Roos from Swerea IVF.

Circular Design Speeds
Task Deliverable:
THEME1 - SRF1.1



Rebecca Earley, UAL and Jodi Everding, Fabric and Trim Manager at Filippa K during one of the workshops at Filippa K HQ in Stockholm.

Value to Others

recommendations, guidelines and tools for others

On June 8th, the first in a series of 'Value to Others' seminar was held on the topic of strategic design thinking for circular design. The participants were a selected group of Swedish designers and fashion practitioners. As a starting point the concepts behind the industry pilot project Circular Design Speeds with Filippa K, was shared. **The seminar was led by Prof. Rebecca Earley and included a practical workshop where the speed of usage for different garments was explored.**

Additional Value to Others seminars during 2018 will be open to industry professionals. This is an opportunity to learn more about strategic design thinking, aiming at enabling the development of a more sustainable and circular fashion industry.

"As academic researchers we see this industry-focused project 'Circular Design Speeds' essential to developing new knowledge and understanding in the area of 'fast' and 'slow' fashion textiles. Clothes we often hope to be slow end up being fast, and even vice versa – yet current materials are all essentially slow; they take time, water, energy, chemicals and valuable resources to make. We want to work with a brand to fully explore whether designing for product recovery and speed can help us make fashion textiles to match our different paces of life."

– Prof. Rebecca Earley
University of the Arts London

supply

theme 2: How to promote a more sustainable circular supply chain?

The systemic change from a traditional linear supply chain to a sustainable and circular supply chain involves a changed mindset. In a circular supply chain the recycling facilities are seen as suppliers and sustainability of the production processes is ensured regardless of material origin.

These issues is the focus for the Supply Theme with the aim of presenting guidance on how the fashion industry can radically reduce carbon emissions, water usage and the use of harmful chemicals.



Dr. Sandra Roos,
Swerea IVF

Doctoral thesis and academic publications on Life Cycle Assessment (LCA) of garments, including chemical impact:

Roos S (2017) Advancing life cycle assessment of textile products to include textile chemicals. Inventory data and toxicity impact assessment. Doctoral thesis. Chalmers University of Technology.

Task Deliverable:
THEME 2 - 2.2.2.3

Roos S, Holmquist H, Jönsson C, Arvidsson R (2017) USEtox characterization factors for textile chemicals based on a transparent data source selection strategy. The International Journal of Life Cycle Assessment.

Task Deliverable:
THEME 2 - 2.2.2.3

LCA database including chemical impact



In February Dr. Sandra Roos defended her dissertation; 'Advancing life cycle assessment of textile products to include textile chemicals'. **The study is the first of its kind since the assessments includes the entire life cycle of a garment**, from extraction of raw materials to product disposal, including chemical impact.

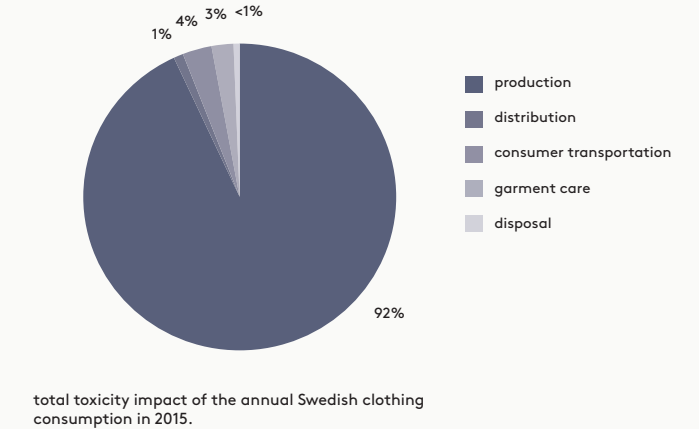
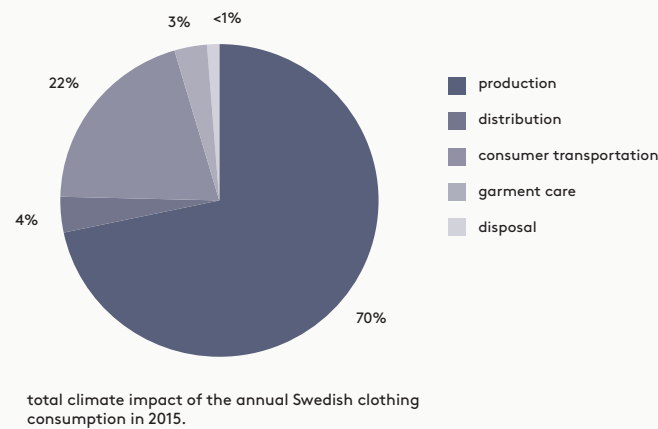
Via this report and published article, **Mistra Future Fashion makes a strong scientific contribution directly into the on-going methodology development of LCA and toxicity**. The research accounts for new knowledge, like comparing quantitatively the eco-toxicity impacts from the cotton cultivation and the wet treatment. For example, if we look at direct emissions of toxic chemicals, **the wet treatment is likely to give 20 times more damage than the cotton cultivation. In total 92% of the toxicity impact stems from the production phase**.

Furthermore, the results show that **70% of a garments climate impact stems from the total production phase**, such as fiber production, yarn production, weaving, dyeing, finishing, sewing, surface treatments, etc., due to its energy, water and chemical usage. Within the boarder of consumer choices, **22%** of the total impact steam from

transportation and only **3% from garment care**. Thus, taking the bike to the store reduces the climate impact of a garment at a greater extent than washing at low temperatures. This new data presented **highlights the importance of considering the entire value chain** when assessing a garments environmental footprint.

At present, both fashion companies and consumers experience challenges in understanding what impact clothing have due to limitation of facts. The major advantage of LCA is therefore that it provides a quantitative measure of the environmental impacts, for example climate change and water scarcity. This means that **it is now possible to calculate the effectiveness of various improvement measures**. Using the data designers, buyers, fashion brands and producers can make relevant decisions in regards to everything from fiber and production methods to shipping. In addition, consumers and other stakeholders can be offered a **new sense of transparency** and a receipt of a garments environmental impact.

In 2018 Dr. Sandra Roos will be taking the next step in her research by converting LCA data into useful tools for the fashion industry together with stakeholders.



"We are very proud of the work that Dr. Sandra Roos has performed within life cycle assessment of textile products in regard to including textile chemicals used in the production processes. The response has been overwhelming and the results will be used to create a practical tool for the textile industry.

There are many challenges in the textile area, but also great possibilities of reducing environmental impact and increasing resource efficiency. We have actively participated in the work behind the national initiative 'The Swedish Sustainable Fashion Wonder', which is an important step towards a circular economy for textile materials."

- Mats Lundin
CEO
Swerea IVF

“Turning from a linear to a circular resource model for fashion and textile will be crucial to secure a prosperous future of fashion within the planetary boundaries. Mistra Future Fashion with its holistic perspective and research is an important actor in the transition and the acceleration of the systemic change that needs to happen towards a circular fashion industry.

The H&M group has set a vision to become 100% circular and we are convinced that a circular resource model is the only way forward. We see that we need to change the way that fashion is made and used so that development can happen in a way that the planet can afford. During 2017 we have seen great progress in the Mistra Future Fashion research program in the areas of preventing microplastic pollution, recycling and separation technologies for textile fibers, LCA studies and circular design to mention a few. All are very important stepping stones towards a circular fashion future.”

- Cecilia Strömblad Brännsten
Acting Environmental Sustainability Manager /Circular Economy Lead
H&M group



microplastics

shedding of microplastics from polyester fabric

In early 2017 researchers at Swerea IVF began a study on microplastic shedding. This study was one of the first steps taken in a larger project and describes an **experimental evaluation of whether the shedding of microplastics from different types of polyester fabric is dependent on construction parameters.** The study included three active industry partners: **H&M, Filippa K and Boob.** Working closely with the industry makes it possible to efficiently identify practical issues and frame recommendations ready to be implemented.

Micro-sized particles of plastics, so called ‘microplastics’ are causing an environmental problem in marine and coastal waters. The oil-based microplastic particles attract contaminants that are normally not soluble in water. When the microplastics enter animals and plants in the aquatic environment, they bring contaminants with hazardous properties with them. Since the fashion industry is identified as one of the origins of microplastics the relation between polyester fabric properties and microplastics shedding needs to be further examined.

recommendations:

- develop a standardised test method for microplastics shedding from fabrics
- differentiate between fibres and other microparticles that shed from fabrics
- investigate whether fibres or other microparticles are most relevant for the environmental impact
- remove microparticles from fabrics already at the production stage
- if microparticles are collected (preferably using dry methods), they should be disposed of in a safe way

The study showed no support for the **assumption that fabrics made of recycled polymers shed more than fabrics made of virgin polymers.** It might instead be assumed that the concern of fleece material from recycled polyester, thought of as a main cause to the microplastics problem, is explained by the fact that fleece is a material that has traditionally been made from recycled polyester bottles.

In addition, the study shows that using an **ultrasonic cutting machine instead of regular scissors when cutting the fabric reduces the shedding significantly.** When testing the two methods a total number of 890 fibres were shed from the ultrasonic cut fabric and 1927 fibres were shed from the scissor cut fabric.

In 2018 the study continues in the project ‘**MinShed**’, lead by Dr. Christina Jönsson at Swerea IVF with an added number of industry partners.

shedding reduced if:

- brushing and/or shearing is reduced
- ultrasound cutting is applied in the cut & sew process
- microparticles on fabrics are removed already at the production stage

study lead by Dr. Sandra Roos, Swerea IVF, assessing microplastics shedding from polyester fabrics:

Roos S, Arturin O L, Hanning A-C (2017) Microplastics shedding from polyester fabrics. Mistra Future Fashion report.

Task Deliverable: THEME 2 - SRF.2.1.1



user

theme 3: How can users contribute to a more sustainable fashion system?

Sustainable fashion consumption in the research context of Mistra Future Fashion is defined as making more environmentally or socially friendly fashion consumption choices, e.g., buying more sustainable product alternatives or engaging in alternative forms of production and consumption processes.

Three main research areas of interest from a consumer point of view are relevant:

- 1. The user perspective: how to make consumers behave more sustainable
- 2. The policy perspective: helping consumers to identify sustainable choices and showing sustainable behavioral alternatives
- 3. The business perspective: business models for reuse, upcycling and sharing

field report mapping consumer attitudes and behaviour. Data used in several additional articles and reports:

Gwozdz W, Nielsen K S, (2017) Field report - Consumer Survey. A Mistra Future Fashion Report.

Task Deliverable: THEME 3 - 3.1.1.1



Ass. Prof. Wencke Gwozdz, Copenhagen Business School



Kristian S Nielsen, Copenhagen Business School

consumer survey

field report mapping user attitudes

What are consumers’ intention and use of new business models such as clothing libraries, leasing agreements and second-hand? How do customers behave in their fashion consumption and in particular in terms of sustainable fashion? To answer these questions comprehensive data on consumer attitude was collected and analyzed. The data enables an understanding of consumer behaviour with the goal of finding suitable communications tools to nudge consumers to act more sustainably.

The research sheds more light on patterns within purchase, use and maintenance, and discard phases by analyzing unique data from 4617 adult consumers (aged 18-65) living in Germany, Poland, Sweden and the U.S. Based on their answer the respondents were divided into five segments. At the low end of the spectrum is a consumer segment that earns the least, which consumes mostly budget brand clothing and are least open to alternative more environmentally friendly

business models such as fashion leasing or clothing libraries. At the other extreme lies a small segment that earns the most who engages in high consumption of medium or premium brand clothing and is most open to alternative business models.

In addition to the segments’ different purchase behavior and a varying openness to alternative business models, the research identify differences in willingness to pay for clothing made of material that is more environmentally friendly than conventional fabrics. These observations suggest several promising directions for environmental interventions tailored toward specific consumer segment.

The design and implementation of any strategy emerging out of this data, should take into account that no one message can suit all consumer groups; to be successful, interventions must be adapted to each segments’ consumption patterns.

across all four countries, consumers were unlikely to use clothing libraries and fashion leasing

reselling clothes online and traditional repair services were the most popular new business models with consumers reporting to be somewhat likely to use it in the future

‘fashion’ and ‘style’, and well-being

the relationship between them

Many consumers attach a high degree of importance to decisions relating to what clothes to purchase and wear. These are relevant to understand when nudging sustainable consumption. To carve out these psychological implications, a study explored the conceptual distinction between clothing consumers with a fashion and style orientation.

The findings of this study tell, through the four-country consumer survey, clear support for the conceptual distinction between a ‘style’ and ‘fashion’ orientation. Moreover, the fashion-oriented consumers report a higher endorsement of materialism and lower levels of subjective well-being than style-oriented consumers. Interestingly, the difference in subjective well-being between the two clothing orientations is mediated by materialism. While materialism and

fashion orientation partly overlap, fashion orientation is still conceptually distinct from both style orientation and materialism. This could be, for example, by following the latest fashion trends through alternative means of consumption such as renting or lending.

Consumers with a style orientation exhibit higher levels of subjective well-being than fashion-oriented consumers.

Though style and fashion is often used synonymously, they have divergent meanings. In relation to clothing, style is any distinctive mode of tailoring, whereas fashion is the style prevailing at any given time. A style evolves slowly and is reflective of a person’s identity and way of life. Fashion, by contrast, is temporary, ever-changing and resonating newness.

consumer study on endorsement of materialism. Report and academic article:

Gwozdz W, Nielsen K S, Müller T (2017) An Environmental Perspective on Clothing Consumption: Consumer Segments and Their Behavioral Patterns. Sustainability. 2017 ; Vol. 9, No. 5: 762

Task Deliverable: THEME 3 - 3.3.1.1

Gwozdz W, Steensen Nielsen K, Gupta S, Gentry J (2017) The relationship between fashion and style orientation and well-being. A Mistra Future Fashion Report.

Task Deliverable: THEME 3 - 3.1.1.2

clothing libraries

assessing using LCA data

A 2017 study assesses the environmental benefits of clothing libraries. To achieve environmental gains, the study quantitatively demonstrate the importance of substantially increasing the garment service life and considering the logistics. The logistics is important because increased customer transportation can completely offset the benefits gained from reduced production. This means that the location of clothing libraries matter and that collaborative consumption may not be suitable for all kinds of clothing. Life cycle assessment (LCA) is used to explore the environmental performance of clothing libraries, as one of the possible ways in which collaborative consumption can be implemented, and advantages and disadvantages are compared to conventional business models.

study on clothing libraries using LCA tools:

Zamani B, Sandin G, Peters G (2017) Life cycle assessment of clothing libraries: can collaborative consumption reduce the environmental impact of fast fashion? Journal of Cleaner Production, 162: 1368-1375.



Dr. Gustav Sandin Albertsson RISE

assessing policy instruments

extending active lifetime of garments

report on policies for extending the active lifetime of a garment:

Watson D, Gylling AC, Thörn P (2017) Business models extending active lifetime of garments: supporting policy instruments. A Mistra Future Fashion Report.

Task Deliverable:
THEME 3 - 3.3.2.4



David Watson,
PlanMiljö



Anja Charlotte Gylling,
PlanMiljö

In present fashion system there are many opportunities for businesses that derive value via extending the active lifetime of a garment. A large number of businesses have arisen in the past few years attempting to do so through for example leasing or re-design. However, these **businesses face a range of economic, legal and capacity obstacles which they need to overcome if they are to expand from niche to mainstream.** Government can assist businesses in overcoming these obstacles through adoption of policy instruments.

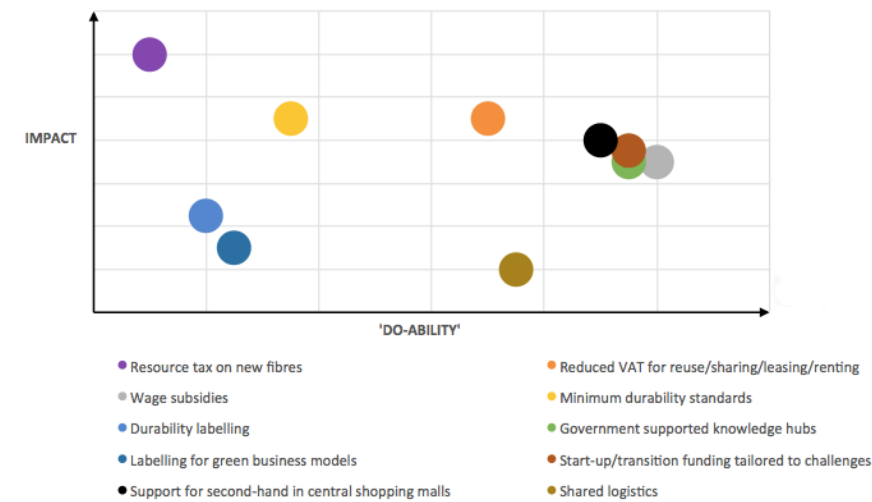
In a 2017 study lead by PlanMiljö **ten potential policy instruments** for overcoming these obstacles were selected from a wider pool and evaluated. Some of the instruments would require regulation changes; others are economic or information-based.

A small group of stakeholders plotted potential magnitude of impact against doability. The results found that there is no

silver bullet that would both have a high impact and be relatively easy to get accepted and implemented. However, the stakeholders found the following **instruments most favourable:**

- **reduced VAT for reuse, sharing, second-hand, repair, leasing**
- **support for second-hand in central shopping malls**
- **start-up transition funding and government-supported knowledge hubs**
- **wage subsidies targeted at these models**

All instruments explored can be carried out at national or local level in Sweden, rather than being implemented at EU level. Moreover, there is strong level of synergy and compatibility between the instruments. **As a package deal they could provide considerable support to business models aiming at extending the lifetime of garments.**



ten potential policy instruments assessed by interviewed stakeholder.

assessing new business models

extending active lifetime of garments

From another point of view, the question of how to extend the active lifetime of a garment can be evaluated from a business model perspectiv. An additional study was conducted during 2017 evaluating business models within reuse, collective use and prolonged lifetime in order to define drivers, strengths, weaknesses and factors of success. **What business models can really extend the lifetime of a garment?**

This report highlights the obstacles and possibilities of present industry initiative. Results derive from stakeholder interviews. **Low awareness amongst consumers and suppliers** is identified as one of the key difficulties. Furthermore are business models within leasing, repair and re-design **essentially dependent on access to free material and voluntary workers** in order to make a profit. Stakeholders see a current lack of incentives and policy measures supporting these businesses. By emphasizing these needs we can take the next step forward.

Measures of success in this report include making profit (or break-even in the cases of non-profit initiatives), increased awareness/ engagement from customers/citizens and increased active lifetime of textiles. Based on the collected stakeholder views, potential success factors for business models for increased reuse, collective use and prolonged lifetime of textiles were identified:

- **access to (free) materials**
- **access to volunteers**
- **efficient logistics**
- **finding the right material/garments**
- **finding understanding from investors /financial institutes**
- **good agreements with suppliers**
- **keeping the customer interested**
- **rapid establishment of the brand /business model**
- **time since establishment**

report on business models for extending the active lifetime of a garment:

Elander M, Watson D, Gylling A C (2017) Evaluation of business models for increased reuse, collective use and prolonged life time of textiles. A Mistra Future Fashion Report.

Task Deliverable:
THEME 3 - 3.3.3.1

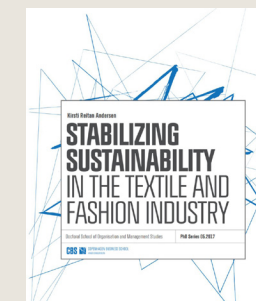


Maria Elander,
IVL Swedish Environmental
Research Institute

exploring organizational change

doctoral thesis

In 2017 Dr. Kirsti Reitan Andersen published her thesis 'Stabilizing Sustainability in the Textile and Fashion Industry' at Copenhagen Business School. The thesis investigates how organizations can change towards practising sustainability, focusing on the potential of taking a design approach to bringing about processes of organizational change. Questions explored are 'For what reasons can organizations within the textile and fashion industry change towards practising sustainability?' and 'How is design thinking being mobilized within current conversations about organizational change towards practising sustainability?'



Andersen KR
(2017) Stabilizing Sustainability in the Textile and Fashion Industry. Doctoral thesis, PhD Series 05.2017. Copenhagen Business School, Denmark.

recycling

theme 4: how to increase textile fiber recycling?

The demand for virgin textiles and textile products is expected to increase significantly with global population growth and a rapid increase in the global middle class. At the same time, the production of textile fibers is responsible for significant global impacts. The textile industry is facing a major future challenge in securing supply and in environmental impacts for which it is responsible.

At present cotton and polyester constitute more than 90% of the materials used in the textile industry, thus the industry urgently needs to make more effective use of textile fibers at every step in the value chain. Therefore, the aim of Theme Recycling is to explore post-consumer cotton and polyester; in particular by assessing how cotton and polyester mixtures can be separated and recycled.

doctoral thesis and academic publications laying the groundwork for Blend Re:wind:

Palme A (2017) Recycling of cotton textiles: Characterization, pretreatment, and purification. Chalmers University of Technology.

Palme et al. Development of an efficient route for combined recycling of PET and cotton from mixed fabrics. Textiles and Clothing Sustainability (2017) 3:4

Task Deliverable:
THEME 4 - 4.1.1.1 & 4.1.2.1



Dr. Anna Palme
Chalmers University of Technology



Dr. Hanna de la Motte
RISE

blend re:wind

a new method for separating both cotton and polyester from a cotton/polyester blended textile

In November the Blend Re:wind recycling process was presented. **For the first time ever there is a method for separating both cotton and polyester from a cotton/polyester blended textile.** This revolutionary process is the result of six years research and the results are crucial for large-scale commercialization and future production of recycled textile.

The Blend Re:wind innovation has been developed within Mistra Future Fashion by **researchers at Chalmers and RISE together with the forest industry company Södra.** Cotton and polyester fibers are separated in a chemical process and divided into **three clean outputs; cotton and the two components of polyester**, one in solid and one in liquid form. The cotton is then used for making new high quality viscosity filaments and the polyester can be rebuilt into new strong fibers. This produces circular product streams and means that we are one step closer to closing the loop for textiles.

A doctoral thesis project by **Dr. Anna Palme** set the groundwork for the innovation. Understanding how cotton is affected by wear has been fundamental in the project and therefore Dr. Palme has done extensive studies of worn cotton/polyester sheets discarded from hospitals. **By using the cotton extracted from the worn sheet, high quality viscose filaments could then be produced.**

A significant advantage of the Blend Re:wind process is that the separation takes into account existing industries. **The goal has always been to integrate with existing forest and chemical industry or recycling initiatives.**

“The Blend Re:wind viscose has the same quality as filament made from commercial dissolving pulp generated by the forest industry and used in viscose production. This means that the material can hopefully be easily integrated into these processes. The separated polyester can be polymerized into a high quality product and is suitable for integration into existing industry. There are already established collaborations with industry actors, and experiments are being carried out.”

- Dr. Anna Palme
Chalmers University of Technology



“The new process Blend Re:wind is an important step in making the textile value chain more circular.”

- Mats Wallin
Mgr. Science Relations
Södra Cell AB



report assessing the impact of policies for recycling:

Elander M, Tojo N, Tekie H, Hennlock M (2017) Impact assessment of policies promoting fiber-to-fiber recycling of textiles. Mistra Future Fashion.

Task Deliverable: THEME 4 - 4.3.7.1



Maria Elander, IVL Swedish Environmental Research Institute



Ass. Prof. Naoko Tojo, International Institute for Industrial Environmental Economics

EPR policy

enabling fiber-to-fiber textile recycling

IVL Swedish Environmental Research Institute (IVL) and the International Institute for Industrial Environmental Economics (IIIEE) have investigated policy options promoting fiber-to-fiber recycling of textile waste. The ambition is to contribute to and broaden the discussion regarding potential policy measures in the textile field as well as potential elements that can be included in such policies.

Ten policy measures promoting fiber-to-fiber recycling of textiles, were identified and described. Two policy measures were selected for impact assessment: **mandatory extended producer responsibility (EPR) and refunded virgin payments (RVP)**. In order to gain industry insight stakeholder views on the identified policy measures were collected during a workshop and via an online questionnaire.

The results shows that **mandatory EPR and a RVP system have large positive impacts on fiber-to-fiber recycling as well as overall recycling of textiles**. Researchers see a need to broaden the scope regarding potential policy measure, **both upstream and**

downstream improvements achievable with the right scope and design of a mandatory EPR. Furthermore, a system for refunded virgin payments would contribute to closing the loop for textiles.

An important aspect for a smooth and solid implementation is **that a newly introduced system is accepted by as many stakeholders as possible**. This makes it critical for producers to consult with existing actors regarding the a new proposed systems. A change of systems and change of mindset is needed.

In 2016 The Swedish Environmental Protection Agency (EPA) proposed two targets regarding textile waste aiming at reducing the amount of textile waste and at increasing reuse and recycling of collected textiles. In comparison to present Swedish system, reaching the set targets would mean more than double the amount of separately collected textiles and more than quadruple the recycling of textiles. In order to reach the proposed target it is assessed that policy measures promoting fiber-to-fiber recycling of textiles are necessary.

re:mix

separation and recycling of elastane & nylon blends

Textile blends containing **elastane and/or nylon are very problematic in a recycling processes**. Nevertheless, these materials are growing on the market and can be found in for example stretch jeans and leggings. Therefore, new recycling solutions are highly sought after.

The Re:Mix project undertakes this problem with the ambition to accelerate the transition for the textile industry towards a circular economy. The project partners identified two separation methods, which could also work in combination, 1) **melting of synthetic fibers; and 2) design of new specific enzymes that will act as biocatalysts** for the degradation of a specific polymer that further facilitates the resynthesis of the polymers. **The method provides nylon or elastane pellets that can be used as raw materials in processes such as spinning and compression molding.**

The first phase of the project, including mapping existing market possibilities were completed in September.

In late 2017 Re:Mix entered phase two where focus is on enzyme design in combination with melt-filtration evaluation. The project was granted further funding from Re:Source, continuing until June 2019. The researcher on enzymatic design within Re:Mix II, Dr. Per-Olof Syrén at KTH/SciLifeLabs has also received Formas funding for ‘**TexZymes**’ to further develop the enzymes that may be relevant in Re:Mix.

Partners within Re:Mix II are **BOKU, Boob Design, Fearing, Houdini Sportswear, I:Collect, KTH Royal Institute of Technology, Radici Yarn, RISE, Swedish Stockings, Swerea IVF, Texaid Textilvertungs and Invista.**

report on separation of elastane and nylon fiber blends:

Östlund Å, Syrén PO, Jönsson C, Ribitsch D, Syrén M (2017) Re:Mix – Separation and recycling of textile waste fiber blends. A Mistra Future Fashion Report.

Task Deliverable: THEME 4 SRF.4.1.1



Dr. Åsa Östlund RISE

recycling PET with nanoclay

academic publication on separation methods for PET:

Guo, Z, Lindqvist, K, W and de la Motte, H (2017) An efficient recycling process of glycolysis of PET in the presence of a sustainable nanocatalyst. Journal of Applied Polymer Science, submitted manuscript.

In a study lead by Zengwei Guo, from Swerea IVF, results on a **new efficient method for sustainable recycling of PET** is presented. By using the nanoclay ‘Perkalite’ as a catalyst instead of more commonly used heavy metals in the recycling process we stand to gain both in terms of decreased toxic metal emission and a decrease in energy consumption.

PET (poly ethylene terephthalate) is the fourth most produced polymer in the world commonly used to make polyester fibers.

When attempting to recycle PET in a textile-to-textile scenario the quality of the

used fiber is often not good enough to be directly used in re-production. One method to enhance the quality of the used fiber is to completely break down, depolymerize, the PET into pure building blocks before it can be manufactured into high quality polyester textile again. Up until now this process has meant high levels of toxic emission. The method contributes to a possible future circular solution of synthetic polymer.

“It is of great importance that we as a company contribute to the development of a more responsible and sustainable textile industry and minimizing its impact on the environment. This means that we need to look at all processes, from raw material use to extending the lifetime of garments, and finally have a sustainable end-of-life solution. Mistra Future Fashion enables us to take part of interesting projects within different phases of the product lifecycle, from manufacturing to user phase and recycling, with the focus on creating circular and sustainable systems. One of Mistra Future Fashion strengths is that many different actors, industry partners, companies and organizations, join and work together towards the same goal; to make the industry more sustainable. We all stand in front of the same challenge to turn the negative impact the textile industry have on the environment.

Re:Mix is one of the projects we are involved in. The project comprise a group of different companies from the textile industry, other industries and scientists, that are working together to find a solution of separating and recycling fiber mixes. To create more circular cycles as soon as possible, and dramatically minimize the raw material use within the industry, companies, organizations and research groups from different fields needs to cooperate. The Re:Mix project gives us valuable contacts and possibilities to be a part of the solution.”

- Malin Wetterbrog
Material Development
Houdini sportswear AB



value to others

moving research forward

Enabling new knowledge to be leveraged and utilized is a key focus of the Mistra Future Fashion research program, i.e. bringing 'Value to Others'. It's about making sure the research conducted also gets implemented, whenever and wherever relevant. For example, in the Circular Design Speed project a specific Value to Others workshop was held in June 2017 targeting a broader audience of designers, buyers and brands.

engaging in international networks

Engaging in international networks aims to enable further use of the Mistra Future Fashion results. In March 2017 Mistra Future Fashion was Affiliate Partner during the birth of the innovation hub 'Fashion for Good' in Amsterdam. In May 2017, Mistra Future Fashion became Affiliated Partner and a research science partner to Ellen MacArthur Foundation's textile initiative 'Circular Fibres Initiative', where several reserachers contributed with data and knowledge input for the report 'A textile

Economy - Redesigning Fashion's future'.

The engagement in the industry network **Sustainable Apparel Coalition (SAC)** continued in the set-up of the Higg Index and in its Transparency Group. The program also continued to support the **European Clothing Action Plan (ECAP)** with Program director Sigrid Barnekow and Ass. Prof. Rebecca Earley at UAL as members of ECAP's advisory group.

contributing with knowledge at national level

IVL Swedish Environmental Research Institute (IVL) and the **International Institute for Industrial Environmental Economics (IIIEE)** have investigated policy options promoting fiber-to-fiber recycling of textile waste. In the fall of 2017 Maria Elander, IVL and Ass. Prof. Naoko Tojo, IIIEE met with the Ministry of Environmental and Swedish EPA to present the findings and results. In December, a half-day workshop was held at the Swedish Trade Federation presenting a deep-dive into the policy research and findings. The work will countinue during 2018.

engaging in sister projects

The more the merrier – enabling systemic change is not done by one actor in isolation or in one part of the textile and fashion industry ecosystem. It requires lot of efforts, by lots of people and organizations. **Researchers engaged in Mistra Future Fashion are involved in several other research projects** such as the Swedish strategic innovation project BioInnovation and its 'Närodlat textil' textile initiative, the EU Horizon recycling project Trash2Cash, the EU project NeoCel and the sorting project SIPTex etc.

In addition, Mistra Future Fashion supported other research on textiles. In conjunction with the Annual Program meeting in September 2017 in Stockholm the **Nordic Council of Ministers** was invited to arrange a workshop with the consoritum members and other stakeholders, under the lead of David Watson from PlanMiljø.



"Mistra Future Fashion was a key contributor to the report 'A new textiles economy, redesigning fashion's future', launched by the Ellen MacArthur Foundation in November 2017. Mistra Future Fashion's ability to bring together world leading researchers to build a credible evidence base that takes a systems view of the fashion industry makes them an important actor in the transition to a new textiles economy."

- Francois Souchet
Lead of Circular Fibres Initiative
Ellen MacArthur Foundation



"Mistra Future Fashion is an excellent example of research at its best. We have come a long way in just a couple of years, and I think this is partly due to the fact that fashion companies and other stakeholders have been involved from the start, helping to define problems that needs to be solved and willing to try out new business models."

- Maria Sandow
Senior Advisor, Sustainability
Svensk Handel (Swedish Trade Federation)

"Sustainability is the new Quality. Quality and high added value is what makes European textiles different, and yet that's no longer enough to compete. Sustainability joins quality as key factor of competitiveness, it drives investments and find its place at the center of the growth strategy of more and more of the 177.000 European textile and apparel companies. Better products and production processes come with a cost and, most importantly, need partnerships all along the value chain. We look forward to work with Mistra Future Fashion to build up these partnerships and deliver all across the European industry"

- Mauro Scalia
Manager of Sustainable Businesses
Euratex



events – Research seminar for journalists arranged by Swedish EPA Dr. Sandra Roos from SwereaIVF presented ‘Killing myths and enabling fashion industry to become sustainable’ and Dr. Åsa Östlund from RISE talked ‘Possibilities in future textile recycling’ (Jan). Dr. Kate Goldsworthy from UAL guest lecture at Beckman’s College of Design on Sustainable Design (Feb). Mistra Future Fashion Program Director Sigrid Barnekow spoke about future consumers and transparency at the **fashion conference Modebranschens Dag** arranged by fashion industry magazine **Habit in Borås** (April). Barnekow participated at a panel stakeholder discussion regarding **Transparency** arranged by **Sustainable Apparel Coalition** with the **Swedish School of Textiles** in Borås together with Bruno Pieters, from Honest By, Sofie Schop from SAC, Hendrik Alpen from H&M, Professor Sandy Black from Center of Sustainable Fashion London, Sarah Ditty from Fashion Revolution (April). At breakfast seminar arrange by Kemi and **Materialklustret at Johannesbergs Science Park** Dr. Hanna de la Motte held a talk about ‘Recycling from a textile perspective’ (April). In a round table event arranged by **the Swedish government** Barnekow spoke about the fashion industry challenges and need of shift towards circular economy system, including highlighting the pioneering work by Sweden to Swedish politicians and other fashion stakeholders (May). ‘How to extend lifetime of products and re-use’ – table discussion by exemplifying with the textile and fashion sector led by Barnekow at **World Circular Economy Forum** related to the **United Nation’s Ten Year Framework of Programmes on Sustainable Consumption and Production (10YFP)** in Helsinki (June). Barnekow moderated a stakeholder event arranged by charity organization **Myrorna at Almedalen** in Visby on the topic of how to nudge consumer behavior with the panel members Ida Lemoine from Beteendelabbet, Susanne Sweet from Stockholm School of Economics /Mistra Future Fashion and Emma Enebog from Myrorna (July). During **Almedalen** in Visby Sigrid Barnekow participated in a panel dialogue on bio economy and sustainability by showcasing fashion industry, arranged by BioInnovation (July). During **World Water Week** in Stockholm Swedish Textile Water Initiative (STWI) arranged the ‘Re:Use, Re:Make, Re:Think Fashion’ showcase that presented sustainable Swedish fashion brands, under moderation of Barnekow (Aug). In the Swedish fashion podcast ‘**Modepodden**’ Barnekow discussed future sustainable fashion options together with designer Naim Josefi and Jessica Johannesson from Stockholm Fashion District (Sep). Dr. Gustav Sandin Albertsson from RISE attended the research project **Trash2Cash podcast** and talked about conducted review of the environmental impacts of textile reuse and recycling (Oct). Barnekow participated in two panel discussions around sustainable fashion during the media day **FABday** with **Damernas värld** och **Mama Magazine** (Oct). Barnekow participated in **Design-BAR’s** panel hosted by **Swedish Institute in Paris** discussing about the textiles of tomorrow together with Mikael Lindström from RISE and Christine Browaeys from T3Nel (Nov). Barnekow participated in a panel debate together with Ida Lemoine from Beteendelabbet, Alexandra Davidsson from Medveten Konsumtion, Cornelia Sun and Vanessa Rothschild from H&M arranged by **109world** in Stockholm (Nov). Mistra Future Fashion experts Dr. Hanna de la Motte from RISE, Ass. Prof.Susanne Sweet from SSE, Dr. Kate Goldsworthy from UAL and Barnekow contributed with input to the **Ellen MacArthur Foundation report ‘A new textiles economy: redesigning fashion’s future’** (Nov).

mistra future fashion events – Launch event May 4th for the **Circular Design Speed** project together with **Filippa K**, at Alma in Stockholm. The project is led by Prof.Rebecca Earley & Dr. Kate Goldsworthy of University of the Arts London. The two year project includes researching, developing and testing of new strategic design for 100% circular fashion garments. At the launch the speaker list consisted of Becky Early and Kate Goldsworthy from UAL, Elin Larsson, Sustainability Director at Filippa K, and Program Director Sigrid Barnekow. The event was open to special invited guest and stakeholders, as well as press.

During **Almedalen** Mistra Future Fashion arranged a collaboration event with **Svensk Handels** speaking about the new report on mandatory EPR that included full lifecycle aspects, including upstream improvements. Discussion regarding ‘How can Sweden become best at ending the textile cycle?’ (july).

Annual Program Meeting Sep 27-28, Stockholm. Around 90 guests, researcher partners and industry partners from all different parts of the value chain, producers, designers, fashion brands, charity/reuse, recycling, forest industry and policy makers, were gathered for Mistra Future Fashion’s Annual program meeting in Stockholm. Six years into the program it was an extensive review of results coming out from the program. Day 1 was dedicated to **review of results, new knowledge and innovations**, all with purpose to contribute to the program vision, to enable a systemic change of the fashion industry and society. Day 2 was dedicated to **4 workshops for specific research tasks**: ‘Criteria for Sustainability – Practical use of the concept of Sustainability’, by Dr. Sandra Roos at Swerea IVF and Dr. Gustav Sandin Albinsson, RISE ‘Making use of LCA data’, by Dr. Roos ‘Is in-built recyclability a future track of sustainable cotton coloring?’ by Hanna de la Motte at RISE and Romain Bordes at Chalmers ‘Driving more sustainable consumption’ by Ass. Prof. Claudia Rademaker at Stockholm University and Dr. Wencke Gwozdz at Copenhagen Business School.

dissemination examples

A broad mix of activities was conducted throughout the year targeting consumers, politicians and industry.



contributions 2017

doctoral theses

Andersen KR (2017) Stabilizing Sustainability in the Textile and Fashion Industry. Doctoral thesis, PhD Series 05.2017. Copenhagen Business School, Denmark.

Palme A (2017) Recycling of cotton textiles: Characterization, pretreatment, and purification. Chalmers University of Technology.

Roos S (2016) Advancing life cycle assessment of textile products to include textile chemicals. Inventory data and toxicity impact assessment. Doctoral thesis. Chalmers University of Technology (published 2016, defended 2017).

Vuletic C (2015) Transitional Textiles - a craft-based journey of textile design practice towards new values and roles for a sustainable fashion industry. University of the Arts London. Published in 2017.

academic publications

Earley R (2017) Circular Design Futures. The Design Journal, vol 20, issue 4, pp421-434.

Earley R (2017) Designing Fast & Slow. Exploring fashion textile product lifecycle speeds with industry designers. EAD12, Rome April 2017. The Design Journal. Special Issue, 2018.

Goldsworthy K (2017) The Speedcycle: a design-led framework for fast and slow fashion lifecycles EAD12. Rome April 2017. The Design Journal. Special Issue, 2018.

Guo Z, Lindqvist, K., W. and de la Motte, H (2017) An efficient recycling process of glycolysis of PET in the presence of a sustainable nanocatalyst. Journal of Applied Polymer Science, submitted manuscript.

Gwozdz W, Nielsen K S, Müller T (2017) An Environmental Perspective on Clothing Consumption: Consumer Segments and Their Behavioral Patterns. Sustainability. 2017 ; Vol. 9, No. 5: 762.

Palme et al. Development of an efficient route for combined recycling of PET and cotton from mixed fabrics. Textiles and Clothing Sustainability (2017) 3:4.

Roos S, Holmquist H, Jönsson C, Arvidsson R (2017) USEtox characterization factors for textile chemicals based on a transparent data source selection strategy. The International Journal of Life Cycle Assessment, First Online: 01 June 2017.

Zamani B, Sandin G, Peters G (2017) Life cycle assessment of clothing libraries: can collaborative consumption reduce the environmental impact of fast fashion? Journal of Cleaner Production, 162: 1368-1375.

master theses

Haeggblom J (2017) Unfinished stories. Master Thesis. Master of Arts (M.A) Sustainability in Fashion 2016/2017. Esmod Berlin - International University of Art for Fashion.

Spathas T (2017) The Environmental Performance of High Value Recycling for the Fashion Industry: LCA for four case studies. Division of Environmental Systems Analysis, Chalmers University of Technology.

reports

Early B, Goldsworth K, eds. (2017) Full paper Proceedings Circular Transitions Conference.

Elander M, Tojo N, Tekie H, Hennlock M (2017) Impact assessment of policies promoting fiber-to-fiber recycling of textiles. Mistra Future Fashion.

Elander M, Watson D, Gylling A C (2017) Evaluation of business models for increased reuse, collective use and prolonged life time of textiles. A Mistra Future Fashion Report.

Gwozdz W, Nielsen K S, (2017) Field report - Consumer Survey. A Mistra Future Fashion Report.

Gwozdz W, Steensen Nielsen K, Gupta S, Gentry J (2017) The relationship between fashion and style orientation and well-being. A Mistra Future Fashion Report.

Östlund Å, Syrén PO, Jönsson C, Ribitsch D, Syrén M (2017) Re:Mix –Separation and recycling of textile waste fiber blends. A Mistra Future Fashion Report.

Roos S, Arturin O L, Hanning A-C (2017) Microplastics shedding from polyester fabrics. A Mistra Future Fashion Report.

Watson D, Gylling AC, Thörn P (2017) Business models extending active lifetime of garments: supporting policy instruments. A Mistra Future Fashion Report.

book chapters

Lernborg CM, Sendlhofer T (2017) The Case of [Partial] Organizing for CSR: Bridging the Sustainability Gap for SMEs. 285-307. In book: Sustainable development and business, Edition: 1, Chapter: 12, Publisher: SIR, Editors: Markus Kallifatides, Lin Lerpold.

Roos S, Sandin G, Zamani B, Peters G, Svanström M (2017) Will clothing be sustainable? Clarifying sustainable fashion. In: Muthu SS (ed.). Handbook of Textiles and Clothing Sustainability. Springer.

conference contributions

Goldsworthy K (2017) The Speedcycle: a design-led framework for fast & slow circular fashion lifecycles. EAD12 Conference, Rome.

Goldsworthy K, Earley R (2017) Playing for Time: seven practice-led workshop tools for making design decisions to extend the life of fashion textile materials and products. PLATE 2017 Conference, Delft.

Roos S, Arvidsson R, Jönsson C (2017) Calculating the toxicity footprint of Swedish clothing consumption. proceedings from the 8th International Conference on Life Cycle Management. Luxembourg. September 3-6.

Sandin G, Peters G (2017) Recycling is good, right? A review of environmental assessments of textile reuse and recycling. Oral presentation at Plastics and Textiles –Recycling and sustainable use in the Nordic region. Gothenburg. October 25-26th.

keynotes & industry presentations

Earley R, The Power of Less. First Thought talks, Galway International Arts Festival. July 22nd.

Goldsworthy K, Rediscovering Sustainability. FashTech Meet Up 9. Industry Talk & Panel. London. January 26th.

Goldsworthy K, Let’s talk about Circular Fashion. Seminar: MAD Brussels. June.

Goldsworthy K, Circular Design; from product to material longevity. Beckmans Fashion School. Stockholm. February 22nd.

Naoko T, Policies promoting fibre-to-fibre recycling of textile –An ex-ante assessment of a mandatory EPR system in Sweden. 9th biennial conference of the International Society for Industrial Ecology (ISIE) and the 25th annual conference of the International Symposium on Sustainable Systems and Technology (ISIE-ISSST 2017) . Chicago. June 25th-29th.

events, workshops, lectures

Earley R, Goldsworthy K, Politowicz K, Granberg H, Presentation at the Trash-2-Cash seminar Dynamic Duos; exploring collaborative research. CCD event. March 6th.

Earley R, Goldsworthy K. How the Future of Materials will look; Filippa K Fast forward workshop. Sweden. June 7th.

Earley R, Materials, models and mindsets for the circular economy, CCD workshop. November 26th.

Elander M, Discussion of the result from ‘Impact assessment of policies promoting fiber-to-fiber recycling of textiles’ study with senior officials in charge of the policy development at the Swedish Ministry of the Environment. Stockholm. November 10th.

Naoko T, Workshop with the industry representatives (T4RI-meeting) where the ‘Impact assessment of policies promoting fiber-to-fiber recycling of textiles’ report was presented and discussed. Gothenburg. December 6th.

Roos S, Presentation at the Textildialogen about LCA and Mistra Future Fashion. October 12th.

Roos S, Presentation to the Swedish Minister of Environment about Mistra Future Fashion at Swerea IVF. December 11th.

Sweet S, Cradelnet Seminar, Panel debate. October 25th.

selection of media exposure 2017

january

Aktuell Hållbarhet, Modebranschen måste bli bättre på att visa sitt hållbarhetsarbete

february

Aktuell Hållbarhet , Två enkla tips som minskar din klimatpåverkan när du köper kläder

SVT, Forskaren: Dags att ta ansvar för plasten från våra kläder

Recyclingnet.se, Slita ut kläder bäst för miljön

march

Ecotextiles, Texaid and Mistra partner on recycling research

Recycling International.com, Experts unite for sustainable clothing initiative

SR, Shoppingresor orsakar stor miljöpåverkan

SR, Kundens transport en femtedel av klimatpåverkan

april

Råd & Rön, Så påverkar dina kläder miljön

Habit Mode, Vägen till konsumentens hjärta

may

Business Green, Ellen MacArthur teams up with retail giants to launch Circular Fibres Initiative

Elle.se, Din röst är viktig när modeindustrin ställer om från linjär till cirkulär

Ecotextiles, Filippa K to undertake circular fashion pilot

Resource, EMF launches circular fibres initiative to map a sustainable future for textiles

WWD.com, Filippa K and Mistra Future Fashion Start Two-Year Project to Make Shoppers More Proactive About Circular Fashion

Makeitlast.se, Will the exploring of circular design speed enable a more sustainable industry

Fashion United, Filippa K ontwikkelt strategie voor productie circulaire mode

Greenstitched.com, Mistra Future Fashion: End of Life vs. End of Use: Circular Economy, Getting More From the Clothes That We Wear

june

Forskning.se, Tre sätt att minska mikroplastutsläpp från polyestertyger

TEKO, Ny rapport om mikroplaster från Mistra Future Fashion

Recycling & Miljöteknik, Stipendium för forskning om textilåtervinning

Habit Mode, Rapport krossar antaganden om polyestertyg

july

DN, Klimatsmartare att slita längre på kläderna än att återvinna dem

SR, Inte bara fleece som är plastbov bland klädesplaggen

Habit Mode, Så minimeras mikrofibers

august

Elle, Upcycling de luxe

Miljö-utveckling.se, Ny metod kan revolutionera textilåtervinning

Forskning.se, Gammal bomull blir nya tyger

september

Göteborgs-Posten, Höstens moderna material

Habit Mode, Seminarium om textil lockar fullt hus

october

SR, *Vetandets Värld*, Jakten på den miljömässigt hållbara textilfibern

Dagens ETC, Hållbarhet på modet efter H&M-skandalen

Habit Mode, Verktyg för cirkulär produktion

Fibre2fashion, Mistra Future Fashion annual meeting held in Stockholm

november

Ecotextiles.com, Recycling ‘breakthrough’ on poly/cotton textiles

Sourcing Journal, Sweden’s Blend Re:wind has a new process for recycling cotton and polyester

Fashionforum.dk, Nu bliver det nemmere at genanvende tekstiler

Aktuell Hållbarhet, Svensk metod kan innebära genombrott för textilåtervinning

Ny Teknik, Genombrott: Ny process för återvinning av textilier

Kemivärlden Biotech, Ny process för textilåtervinning

Sandinavian Man, 100% sustainability is the new black

WWD.com, Nordic Fashion Association Spotlights Sustainable Business Practices

december

Sourcing Journal , Top Textile Innovations of 2017, From Tencel to Polyester and Beyond

Recycling & Miljöteknik, Process återvinner både bomull och Polyester

Habit, Genombrott för textilåtervinning

Make it Last, Editor’s Letter by Lisa: The Year in Fashion Was All About Streetwear, Second-Hand and Sustainability

Fashionunited.uk, Best Of: FashionUnited’s Interviews from 2017

management



Sigrid Barnekow
Program Director
RISE



Dr. Åsa Östlund
Deputy Program Director
RISE



Ass. Professor Susanne Sweet
Research Manager
SSE



Malin Viola Wennberg
Communications Manager
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theme leaders



Dr. Kate Goldsworthy
Theme Leader 1 – Design
University of the Arts London



Dr. Sandra Roos,
Theme Leader 2 – Supply
Swerea IVF



Ass. Professor Claudia Rademaker,
Theme Leader 3 – Users
Stockholm Business School,
Stockholm University



Dr. Hanna de la Motte
Theme Leader 4 – Recycling
RISE

board



Nick Morley
Chairman
Faering Ltd



Margaret Simonson
McNamee
RISE



Anna-Karin Jönbrink
Swerea IVF



Kent Wiberg
Keml



Elin Frendberg
Swedish Fashion Council



Elin Larsson
Filippa K



Michael Lind
Dedicated Industries



Mathilda Tham
Linnaeus University &
Goldsmiths, University of
London



Philip Warkander
Lund University



Malin Lindgren
Co-opted, Contact at
Mistra

financial report

| Updated Program costs 2016, Phase 2 | Total Budget kSEK | SRF supported tasks kSEK | Total Mistra kSEK | Reported Costs 2016 kSEK | Reported Costs 2017 kSEK | Total % used budget kSEK | Inkind contribution from partners * |
|--|-------------------|--------------------------|-------------------|--------------------------|--------------------------|--------------------------|-------------------------------------|
| Design Theme | 6430 | 850 | 7280 | 1463 | 2737 | 24 | |
| Supply Theme | 6580 | 260 | 6840 | 2019 | 1982 | 61 | |
| User Theme | 6740 | 0 | 6740 | 2218 | 1536 | 54 | |
| Recycling Theme | 6950 | 732 | 7682 | 2792 | 2904 | 72 | |
| Program Board, Management, Communication | 9300 | 0 | 9300 | 2582 | 2919 | 72 | |
| Remaining in Strategic Reserve fund | 2408 | - | 2408 | - | - | | |
| Total | 38408 | 1592 | 40000 | 11074 | 9341 | 57 | 5538 (2017*) |

*) Only reported until June 2017



The current system for fashion is broken. Given the environmental impact and challenges linked to production and usage, a new model is required.

Mistra Future Fashion is a research program that focuses on how to turn today's fashion industry and consumer habits toward sustainable fashion and behavior. Guided by the principles of the circular economy model, the program operates cross disciplinary and involves 60+ partners from the fashion ecosystem. Its unique system perspective combines new methods for design, production, use and recycling with relevant aspects such as new business models, policies, consumer science, life-cycle-assessments, system analysis, chemistry, engineering etc.

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