

WP T2 - INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.3 PILOT CASES

D.T2.3.2 PILOT CASES

Version 1

Partner:

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Innovatext - Multifelt Factory

(Hungary)





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ENTeR - Expert Network on Textile Recycling

ENTeR works in five central European countries that are involved in the textile business, to promote innovative solutions for waste management that will result in a circular economy approach to making textiles.

The project will help to accelerate collaboration among the involved textile territories, promoting a joint offer of innovative services by the main local research centres and business associations ("virtual centre"), involving also public stakeholders in defining a strategic agenda and related action plan, in order to link and drive the circular economy consideration and strategic actions.

The approach of the proposal and the cooperation between the partners is oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.



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1. Pilot case description - aim and scope

The stakeholder of the pilot case is the Multifelt Factory, which is the only felt producing company in Hungary. The present - new - the owner is highly committed to environmentally friendly solutions, including waste management of quality guaranteeing a win-win position benefiting both the company and the environment.

“Felt” is a term that can be used to describe a variety of different textiles included felted woven wools, synthetics, and industrial felts. Traditionally, felt is a nonwoven textile composed of loose fibres which are matted together to form a coherent material. ¹There are two types of preparation, the needle felting and the wet felting. Multifelt Factory uses the wet felting technology only and produces 100% wool and wool-viscose mixture felts. The felts are manufactured from Merino wool that is typically sourced primarily from Hungary and Australia.

Currently, their waste is generated in the production of industrial and decorative materials, mainly in the form of cut off material edges. Most of them consist of only 100% wool, but the decorative materials contain viscose, and most of them painted. Their paintings meet the STANDARD 100 by OEKO-TEX requirements. The cut edges of the wool felt are too small to sell as felt for decoration and industrial use, so they are out of their business scope. The company needs to find another way to use these raw materials. These smaller parts contain the same good quality wool, so they are potential raw materials for another type of usage. It could be an extra profit if company could find new features of this form of wool. Wool is particularly well suited for felting and is superior to synthetic fibres. Characteristics include inherent durability and resilience as the crimp or bend in the fibres give it natural elasticity. Such flexibility makes it durable and the outer skin of the fiber acts as a protective film, providing abrasion resistance. Lanolin, the thin waxy coating on wool fibres, makes wool naturally resistant to water and soil. Wool readily accepts natural dyes as they can penetrate the core of the fiber and undergo a chemical reaction making the colour change permanent and intensely saturated. In addition, because wool retains moisture in every fiber, it resists flame without chemical treatment. Instead of burning when touched by flame, wool chars and self-extinguishes when removed. Due to these natural characteristics of wool, Wool Design Felt is high quality, sustainable comes in highly saturated colours and is perfect for demanding design applications. Today felt becomes very popular again. The Do It Yourself activities are very trendy and exercised by many people. Lot of them prepare handmade felts, but the machine-felted materials are also popular. Felt is a versatile textile; industrial, home decoration and fashion designers use it, too.

¹ Felts of the nonwoven class are considered the first textile goods produced, and many references may be found to felts and their uses in the histories of ancient civilizations. The nomadic tribes of north central Asia still produce felts for clothing and shelter, utilizing the primitive methods handed down from antiquity. Source. <https://www.britannica.com/topic/textile/Braiding-or-plaiting#ref359481>

2. Theoretical part

In Hungary, natural wool felts has been produced only in one factory, in Multifelt Factory. Felt is a nonwoven textile composed of loose fibres which are matted together to form a coherent material. There are two types of preparation, the needle felting² and the wet felting³. *Multifelt Factory uses the wet felting technology only and produces 100% wool and wool-viscose mixture felts. Wool-viscose felts contain also at least 60% wool.* Multifelt's felts are available in more than 36 different colours and dozens of thicknesses.

2.1. Wool/non-woven textile/felt - analysis of waste at Multifelt Factory

Characteristics of wool and non-woven textile - favouring their alternative use

The waste produced by Multifelt Factory has features of wool and non-woven technics. Both wool and felt made from wool as a non-woven textile has very particular and useful characteristics. The natural characteristics of the wool greatly favour its alternative uses. As we have already mentioned felt is a highly versatile textile, it can be used for multiple purposes, it has several industrial, domestic and fashion applications.

The natural characteristics of the wool and/or wool waste, which can be utilised, are its

- *inherent durability*
- *resilience due to its natural elasticity*
- *naturally resistant to water and soil due to its lanolin (waxy) coating on wool fibres*
- *easy to colour*
- *flame resistance without chemical treatment as it retains moisture in every fibre*

We can identify the useful characteristics of the non-woven textile as felt and/or felt waste, which can be utilised, as follows:

- *The felt is non-directional; it has no right side or wrong side.*
- *It has consistent, highly saturated, sun-proof colour.*
- *The widths can be up to 180 cm.*
- *It naturally repels soiling and moisture.*
- *Since it is non-woven, it can be cut with the edges left raw.*
- *The thickness and density (of the felt) give it a structural quality that allows for hanging. Installations that do not require any additional support.*
- *It is self-extinguishing and inherently flame retardant.*
- *It has outstanding thermal and acoustic insulating properties.*
- *It is an environment-friendly and renewable resource.*

'Wool felt is the oldest textile known to mankind yet it is ultra-contemporary'

'The longer we work with felt, the more applications we find.'

(Feltum Contemporary Feltworks, www.feltum.com)

² Needle felting: A woven textile that is felted with barbed felting needles. Source: <http://www.nmz.hu/en/mi-a-nemez/>

³ Wet felting: The wool fibers have a biological feature to become felt with added water, steam and rubbing process. With this traditional technology only the pure wool can be felted, or a mixture with high wool content. In this technology, the polyester and other plastic materials are not applicable, because these fibres are not heat resistant. The mixtures we use contain other animal fur or viscose, which is a natural product made from wood. Source: <http://www.nmz.hu/en/mi-a-nemez/>



Felt is a unique engineering material

- Its characteristics may range from those of soft, supple padding to a hard, dense material ideal for imparting highly polished surfaces to glass and metal.
- At the proper density and firmness, felt can seal in lubricants and seal out contamination.
- It can act as a vibration and sound dampening material. Noise Reduction Coefficients between 0.2 and 1.2 can be achieved by using felt.
- Despite modern technological advances in chemical and mechanical engineering, it is the only material that will perform satisfactorily on a cost-effective basis for many lubrication metering, packing and insulating applications.
- Felt's inherent characteristics also make it ideal for a wide range of controlled filtering applications. (aetnafelt.com)
- It has good fluid flow capacity, good permeability
- It can capture large amounts of debris
- Its high natural Lanolin content of the animals' hair makes felt resistant to liquids (feltum.com)
- Felt is an excellent thermal insulator (feltum.com)
- Wool Felt is ecologically sustainable because it is a rapidly renewable resource. As Rapidly Renewable Resource wool felt qualifies for LEED® certification MR Credit 6.0
- It also can be safely disposed of and is 100% BIODEGRADABLE.
- Felt has a life cycle that is substantially longer than any other upholstery fabric.

2.2. Successful examples - possible solutions for the pilot case waste. Selected good practices using an reusing the wool/felt unique properties

As in our pilot project, we focus on wool felt, we think important to look for good practices for use of felt waste in its natural or recycled form. It is important also from the point of view of the target company of the pilot project, actively looking for new ideas to use its felt waste. *Internationally*, there is a large range of good practices for the use of ad reuse of wool felt, and several factories and laboratories deal already with. As concerns Hungary, we have only a limited number of companies dealing with felt and particularly felt waste. In addition, despite that felt is a real engineering material, its potential for industrial applications is utilised yet only marginally. Nonetheless, we find abroad interesting attempts to do it. Some areas where felts of various compositions and densities are successfully applied are the following:

- **Architectural Applications:** wall coverings, murals, furniture, decorative elements
- **Automotive Components:** drive mechanism grease retainers, noise and vibration absorption, transmission fluid filters
- **Electric Motors:** felt wicks and packing deliver constant, metered oil supply
- **Home Appliances:** lint and air seals, rotating shaft lubricators, anti-rattle bumpers
- **Electrical domestic appliances:** qualities such as shock-absorbing, insulating and cushioning make it a perfect material to be used as a lubricant, sealant or gasket mechanism, besides preventing vibrations and noise. (textilolius.com)
- **Polishing and Wiping:** lenses, glass, pottery, floor scrubbers and polishers, metal tubing, rolled sheet steel and aluminium, liquid and semi-liquid coating application
- **Power Tools:** felt lubricators, pressure pads for sanding machines, fuel filters
- **Seals and Bearings:** seal out dirt and dust while effectively lubricating bearing internally

- **Packaging:** high absorption capacity makes it ideal for any kind of packaging
- **Bakery sector:** being a natural and harmless material, it is used to transport bread, both on conveyor belts as well as in carrier baskets. (textilolius.com)
- **Other Applications:** lamp bases, stamp pads, anti-scratch pads, weather stripping, various cushioning (AetnaFelt), toys, footwear, orthopaedics (textilolius.com)

Mapping of good practices - wool felt, use and reuse

Flextiles - Bartlett School of Architecture at University College London

Felt for Architecture - designers Claudio Varone & Anneke Copier

Insulating material- Havelock Wool

Acoustic panels made from end-of-life textiles and cut offs, Kvadrat AS, Denmark

Acoustic divider system made from locally sourced wool felt and ash wood, PLECTERE, Petra Vonk, the Netherlands

Isolena Naturfliese Silentum Acoustic Wool Felt - Isolena Naturfaservliese, Austria

Acoustic Wool Felt Flex - Plexwood, the Netherland

Acoustic Wool Felt Rigid, Plexwood, the Netherland

ECOWall - 3D acoustic panel, Slalom Inc., Italy

SLALOM ECOfelt shape decorative acoustic panel, Italy

Ares Line DECORVOX Wool felt sound absorbing panels, Italy

HEY SIGN RELIEF - wool felt decorative acoustic panel, design by Reimund Braun, Bernadette Ehmanns, Germany

Acoustic surfaces - Cabs Design studio, New Mexico

Interior and product designs - Interiorfelt, Germany and North America

Floor - wool felt and recycled leather, Mixed Stripes, Buxkin, the Netherlands

Feltro legno, combination of carpet and parket, Ruckstuhl AG Teppichfabrik, Switzerland

OZ Wall of light from wool felt and a synthetic resin material, designer Alexandra Devux, France

Reinforced Wool Felt, Wiltex, the Netherlands

Moulded felt, different designs, betterfelt.com, Denmark

Decorative felts in walls, SLALOM, Italy

Solidwool - blending glass fibre and wool

Cook2Design, NeWool, four materials based on potato starch and wool waste cooked together

2.2.1. Wool felt as construction/insulating/acoustic material

a) Architecture use

A building made from 100% felt - “Flextiles”

A group of students from the Bartlett School of Architecture at University College London (Noura Mheid, Hamed Janahi, Minzi Jin, Zoukai Huo) uses the quality of felt to be supple enough to hew into shape yet stiff enough to possess almost *sculptural integrity*. They toughen the felt with resin and using the felt’s load-bearing potential, they designed a self-supporting pavilion. The architectural proposal includes an auditorium, staircase and facade.

Photo 1 Pavilion from felt



The Bartlett team's "Flextiles," offers a "new perspective on how to integrate the structure into a soft material such as fabric and go beyond the typical disintegration between the draping of fabric onto completely segregated support". (Jasmin Malik Chua (2017))

Felt for Architecture, designers Claudio Varone & Anneke Copier

Photo 2 Collection Felt For Architecture, concept of Claudio Varone



Felt For Architecture' is a collection of handmade three-dimensional carpets and wall hangings. The Felt material, made of 100% wool, or combined with silk, flax, cotton and other materials. The material can be manufactured in the form of panels, tapestry, upholstery, as a work of art for walls, floors or in the space. The maximum size of a piece is about 3m x 1.5m. For larger sizes, more pieces can be assembled. The material is suitable for lobbies, corridors, meeting rooms, as well as hotels, shops and homes. (Source: MaterialDistrict).

b) Insulating material- Havelock Wool

' Havelock Wool uses wool as a construction material. Wool scrap used as an insulating material improves the indoor atmosphere by filtering the air, and diminishes humidity that causes an increasing problem; therefore, it prevents mold formation which is due to its keratin content. Thanks to its material structure, it is an excellent acoustic buffer, heat-holder but resistant to fire. Additionally, the chemical immunity and sustainability of the insulation provide serious arguments against the market competition.⁴ (Temesi, p. 6)

c) Use of acoustic qualities of wool - acoustic surfaces - Industrial soundproofing, vibration and sound dampening material

Acoustic panels made from end-of-life textiles and cut offs, Kvadrat AS, Denmark

⁴ <https://woolinsulation.com> (2018.11.10)

Photo 3 Acoustic panels from waste

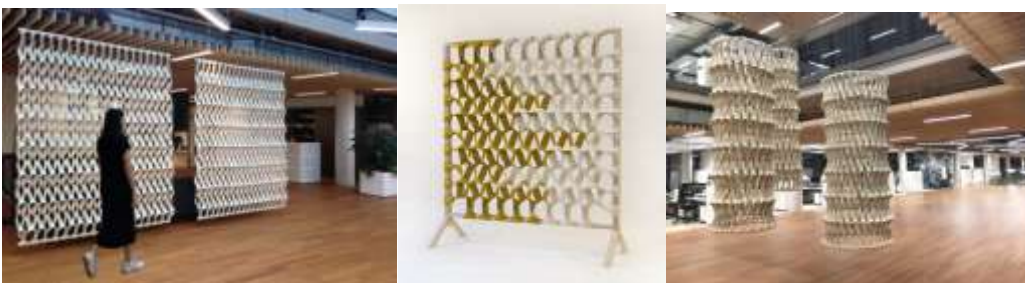


Acoustic Textile Felt is as sound absorbing as it is decorative. The felt material is made from end-of-life textiles and cut offs, with a soft feel and a reference to the tactility of textile. The material is made from wool or cotton, consisting of 70% textile, 30% thermoplastic binder, and can replace various other acoustic materials. (Source: MaterialDistrict)

Acoustic divider system made from locally sourced wool felt and ash wood, Petra Vonk, the Netherlands

Dutch designer, Petra Vonk (petravonk.nl) designed a series of acoustic divider systems from locally sourced wool felt and ash wood.

Photo 4 Acoustic divider systems - PLECTERE



Photos: Petra Vonk

Petra Vonk created a 3D structure with a repetitive pattern. Plectere consist of wool [felt](#) strips that have been woven in a braid-like fashion, creating semi-transparent systems that can be used as partition wall or room divider without sealing off the room. The industrial felt is 100 per cent biobased and locally sourced. Each knit is made by hand in the Amsterdam area, as well as the ash wooden frames. Thanks to the material's flexibility, it can be used as room divider attached to a frame, as well as in tube-form, for instance as an acoustic light shade.

Isolena Naturfliese Silentum Acoustic Wool Felt - Isolena Naturfaservliese , Austria
 Silentum acoustic felt, the product of Austrian company, brand Brand Isolena Naturfaservliese GmbH, is made from seep wool.

Photo 5 Silentum acoustic felt



The modular system was developed in cooperation with architects. It enables the acoustic elements to be easily applied. The combination of individual elements enables individual wall effects in various different colours and forms. It not only improves the acoustics in the room (unpleasant noises in low or very high tones are cushioned), but also filter and sustainably neutralise pollutants and irritants from the air. This creates a comfortable and healthy indoor climate in living and working spaces. (Source: materialdistic.com)

Acoustic Wool Felt Flex - Plexwood, the Netherland

Photo 6 Acoustic Wool Felt Flex



The acoustic wool felt flex designed by the company Plexwood, the Netherlands, consists of a 100% natural (Merino) wool felt layer and a Plexwood veneer. They have a linear groove pattern exposing the wool felt. The 2-layer variety is extremely flexible, suitable for inward and outward curves of a 50 mm radius. The layer of wool felt gives these sheets an acoustic quality, and they can also be chosen for their aesthetics, as the wool felt is available in a variety of colours. s suitable for wall, ceiling, furniture solutions, and sharply curved or flexible forms. The sound absorption coefficient of wool felt 5 mm is, according to UNE-EN ISO 354:2004 up to 0.82 α_s . (Source: materialdistic.com)

Acoustic Wool Felt Rigid, Plexwood, the Netherland

Photo 7 Acoustic Wool Felt Rigid



It is the rigid version of Plexwood acoustic wool felt. It is a 3-layer wood product, consisting of a 100% natural wool felt layer and a Plexwood veneer on both sides with a linear groove pattern exposing the wool felt. It is rigid for wall, ceiling and furniture. A wool felt layer of 100 % natural merino wool is placed between two sheets of veneer. (Source: materialdistic.com)

ECOWall - 3D acoustic panel, Slalom Inc., Italy

ECOWall is a colourful and lightweight 3D acoustic panel.

Photo 8 ECOWall



The panels, which are about 3 cm thick, are covered with coloured ECOfelt, made from 90% sheep's wool and 10% polyester. The inside is made from sound-absorbent material composed by recycled 100% polyester staple fibre. The panels can be attached to the wall or ceiling using screws or strips of Velcro.

Archiproducts wool felt sound absorbing panels include panels like:

Photo 9 SLALOM ECOfelt shape decorative acoustic panel, Italy



(source: aresline.com, www.slalom-it.com)

SLALOM EcoFelt

ECOfelt is available in rolls to cover the walls with a line and secure the design unit, or it can be cut to pantographs in different shapes and sizes to become a decor.

Photo 10 Ares Line DECORVOX Wool felt sound absorbing panels, Italy



(source: aresline.com)

It consists of 16 mm fireproof MDF panel, perforated, hole D 10, 16 mm pitch, coupled with 5mm thick mixed wool felt on the visible side. It is from 80% wool and 20% rayon. Its density is 0,30 gr/cm³ and weight is 1500 g/m². There is a minimum quantity to obtain, it is 18 m².
 (Source: <https://img.edilportale.com/catalogs/DECORVOX-Fonology-212791-cat6ad72537.pdf>)

Photo 11 HEY SIGN RELIEF - wool felt decorative acoustic panel, design by Reimund Braun, Bernadette Ehmanns, Germany



(source: aresline.com)

Designed in 2017, it consists of 40 x 40 cm individual tiles. Five different motifs can be combined individually, positive and negative. Each single tile consists of one layer of felt whereon a circle segment as second layer is fixed. Due to the graphic motif, the 40 x 40 cm wall tile is infinitely extendable.

Cabs Design studio, New Mexico - Acoustic surfaces

The Cabs Design Studio focuses on the acoustic qualities of wool felt. The New Mexico based Submaterial studio focuses on unique wall coverings, acoustic surfaces and decorative panels, all of which are offered to architects and interior designers who prefer the wool felt as a base material. (Temesi, p.5, in submaterial.com)

Interior and product designs - Interiorfelt, Germany and North America

Interiorfelt, the wool fabrication and distribution company, offers finished products for interior design and product design purposes in Germany and North America. Their main product is a hundred per cent cotton wool, which is offered in three different thicknesses and forty-six different colours. Their product range includes acoustical products, floor and wall coverings. The wool to be processed is purchased from Merino sheep farms in New Zealand, Australia, Europe and South America. (Temesi, p.4, in interiorfelt.com)

d) Floor - wool felt and recycled leather

Mixed Stripes, Buxkin, the Netherlands

Mixed Stripes by Floor and Friends is a recycled leather and wool-felt mix material that is suitable for application on floors and walls. Made by hand, this flexible and natural material is composed of 66% wool-felt and 33% recycled leather.

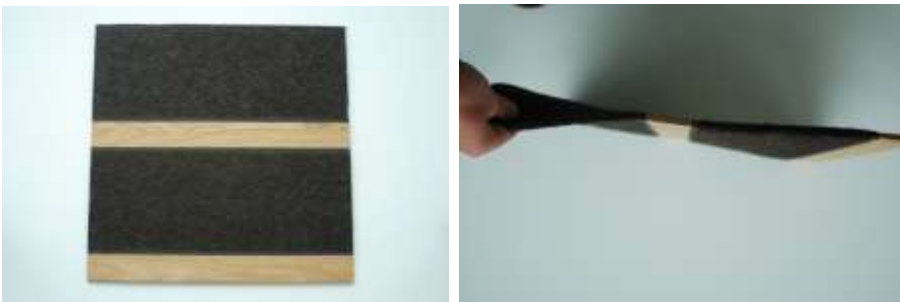
Photo 12 Mixed stripes



The wool-felt combined with recycled leather and an acoustic backing gives a flexible wall and floor covering. It has a textured 'brick-like' appearance and are well suited for use in sustainably and ecologically minded design projects. (materialdistric.com)

e) Feltro legno, Ruckstuhl AG Teppichfabrik, Switzerland

Photo 13 Feltro legno



Feltro legno is a combination of parket and carpet. Oiled oakwood is here combined with felt made from pure virgin wool. Ruckstuhl is known by creating carpets made of natural materials like wool, hemp, wood, cotton, hair, paper etc. (materialdistric.com)

f) OZ Wall of light, designer Alexandra Devux, France

This material consists of a wool felt and a synthetic resin material. It is for indoor using.

Photo 14 OZ Wall of light



The translucent resin that is included in the felt permits the light to pass through and create a new sensorial surface aspect. The felt is available in various colours, the resin is also available in opaque and various patterns. (MaterialDistrict)

2.2.2. Felt - good filtering material

Felt filters utilise the filtering capacity of felt. Felt materials filters are versatile and cost-effective as they can be formed into any three-dimensional shape. They can filter particles from 1 to 200 microns.

Photo 15 Felt filter bags



They can filter particles from 1 to 200 microns. (www.engineersedge.com/filtration/felt-filters-review.htm)

Reinforced Wool Felt, Wiltex, the Netherlands

Photo 16 Reinforced Wool Felt



Reinforced wool felt is a coloured wool felt featuring a woven interlayer. The interlayer makes the material more resistant to friction and tension (>100.000 Martindale). Its application in interiors improves air-quality and comfort. It can bond the air pollutant formaldehyde chemically and can be resolved into its parts, which are not dangerous for human beings (e.g. water). Thickness is around 2 mm. (Source: materialdistric.com)

2.2.3. Designer felts and crafting applications, interior design and decoration

There is an endless possibility to use felt for interior design products and for craft application. For example, bloom shape lamp is made from naturally dyed wool felt. Once installed, the lamp 'grows' under gravity into its final plump shape.⁵ Feltum creates different products, among them furniture (chair), rugs (acoustic 100% Merino wool felt rugs), bags from felt. They use CNC cutters to cut almost any shape, no matter how complex.

⁵ <https://nothrowdesign.com/product/bloom/>

Moulded felt, betterfelt.com, Denmark

Photo 17 moulded felt



The natural wool is carded and then felted around a three dimensional seamless shape, while the felt maintains its strength. The colour can be varied since the wool can be dyed before felting. After felting it is even possible to add prints on the felt. (Source: materialdistic.com)

FilzFelt Inc, USA

Filzfelt is an ecological, sustainable, and renewable material available in 54 colours available and in 5 thicknesses, produced from virgin wool. The sheep's wool is cleaned, carded, and the fibers aligned into batts. It is then compacted and joined by moisture, heat, and agitation until a homogeneous fabric is formed - wool felt. The material is naturally moisture resistant, self-extinguishing, non-directional, available in lightfast and saliva-resistant colors, and provides thermal and acoustic insulation. (materialdistic.com)

Photo 18 FilzFelt products



Decorative felts in walls, SLALOM, Italy

Photo 19 Felts in walls - From serie Petit Pois



Photo 20 From serie *Overlapping*



Photo 21 From serie *Pepite*



2.2.4. Innovative approaches - new material and cooking experiment

'In the small town of Herdwick, The one-time prosperous carpet industry could no longer process the typical dark, rough wool from the area's animals, so the once valuable raw material has slowly become a burden. The designers of Solidwool wanted to make this unwanted material attractive again so they came up with blending glass fibre and wool. Due to the new appearance of the raw material, it can be reused in a wide range of objects. The purpose of continuous material development is to explore alternative ways how to process wool.'⁶ (Temesi, p.7)

'In the framework of the Cook2Design project, run in the Labor, the raw materials used by designers have been investigated through cooking experiments. The result of the research was the production of NeWool, four materials based on potato starch and wool waste cooked together, which were resented in six colour declinations. The output of the process is a 100% recycled organic material, which could be the starting point for future research as the first prototype.'⁷ (Temesi, p. 10)

⁶ <http://www.solidwool.com/> (2018.11.12)

⁷ <http://materialexperiencelab.com/cook2design> (2018.11.12)

3. Catalogue of the waste covered by the pilot case

3.1. Multifelt Factory's felts produced from new and reused wool

Felts of the category called ARTIFELT (IDEA and ZORIN) are produced by Multifelt Factory for artistic and decorative purposes, meanwhile felts of category called INDIFELT (MERINO, VARIO, NATURAL, ISOLA) for industrial purposes.

Table 1 Products of Multifelt Factory prepared from 100% wool

	Ingredients	Thickness, mm	Density, g/cm ³	Width, cm	Band length, m	Colour
MERINO ⁸	100% wool	2-100	0.22-0.6	110	7-14	Nature colour
NATURAL ⁹	100% wool	12, 14, 16	0.22-0.26	120	7-14	Nature colour
NATURAL/JURTA	100% wool	6,8,10	0.18-0.2	110	7-14	Color wool
NATURAL MAX/Technical	100% wool	2-100	0.36-0.42	110	7-14	Color wool
NATURAL SOFT/Saddle	100% wool	14,16	0.3-0.32	110	7-14	Color wool
ISOLA ¹⁰	100% wool	6,8	0.16-0.21	180	25	Nature colour
ZORIN ¹¹	100% wool	1-5	0.26-0.3	140, 160,170	25-30	Natural colour, or painted

Table 2 Mixed product

	Ingredients	Thickness, mm	Density, g/cm ³	Width, cm	Band length, m	Colour
IDEA	60% wool/ 40% viskose	1,2, 3, 4 and 5	0.26-0.3			in colours

⁸ The Merino fleece made from 100% Hungarian, colored wool. It is perfect as pad, vibration dampening, and transport line of ultra-high-temperature products, by-products, seats and body insulation in automotive industry. Fireproof. Because of Merino natural, rustic texture is also applicable for design purposes, even in painted form.

⁹ The Natural fleece made from 100% white and coloured wool. It is perfect as saddle felt, pad, vibration dampening, transport line of ultra-high-temperature products, by-products, seats and body insulation in automotive industry. Fireproof. Because of Natural rustic texture is also applicable for design purposes, even in painted form.

¹⁰ The ISOLA fleece made from 100% white and coloured wool. It is perfect as board cleaner, pad, vibration dampening, seats and body insulation in automotive industry. Fireproof.

¹¹ ZORIN serves as pad, vibration dampening, transport line of ultra-high-temperature products, by-products, seats and body insulation in automotive industry. Fireproof.

VARIO	80% wool/ 20% viskose	2-40	0.36-0.42	110	7-14	Nature colour
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We have to note that the majority of waste in the factory derives from the product, IDEA.

3.1.1. Products from felt produced in Multifelt Factory

Multifelt Factory produces and sells not only rolled felts of different thicknesses and colours but several products from wool felt for industrial and decorative purposes as well. From industrial rolls of felt smaller pieces can be cut and result products like as follows:

Photo 22 Discs of different sizes and thickness



Photo 23 Zaleco pack



Multifelt Factory (or their partner companies) offer also several designer products, like backpack, hand bag, laptop bag, shoppers of different colours (designer Móni Bíró) -

Photo 24 Designs of Móni Bíró



Photo 25 Packs like Praktika creative pack



Photo 26 Seatpads of different colours



Photo 27 Felt pillows of different colours



Photo 28 Pinboard



Source of Multifelt Factory's products: <http://www.multifelt.com/webshop>

Multifelt factory produces products from reused wool too.

Table 3 Products of Multifelt Factory prepared from 100% reused wool

	Ingredients	Thickness, mm	Density, g/cm ³	Width, cm	Band length, m
REMIX (cleaning whiteboard tables)	100% Reused wool	8	0.16-0.17	160	7-14
REMIX FORMA (GS felt) ¹²	100% Reused wool	8-50	0.16-0.17	140	7-14
REMIX ISOLA (Pipe insulation)	100% Reused wool	2	0.16-0.17	8	2,5

3.1.2. Catalogue of waste in Multifelt Factory

Table 4 Catalogue of waste covered by the pilot project in Multifelt Factory Kft.

General Information		
Waste name	Main description	felt
EWC code	European Waste Catalogue	WO, CV
Quantity	Quantity of disposal per year in ton/y or equivalent units (l/y, m ³ /y)	1,5 tonnes/year

¹² REMIX FORMA generally prepared with special cutting and used as soundproofing, dust proofing and vibration damper layer.



Frequency	Frequency of disposal (for example weekly, annual, occasional, seasonal)	occasional
Management	Actual disposal method (e.g. incineration, sell, recycling)	sell, recycling
Physical state	Solid, liquid, gas	solid
Appearance	Aggregate, Composite, Monomaterial, Bulk, Powder, Oil, Pellets, Fibres, Textile	textile
Toxicity	Risk assessment form safety data sheet	no toxicity
Outcoming Sector	Main activity or factory sector that generating the waste	material edge
Additional information		
Material type	Glass, Polymers, Ceramics, Metals, Carbon-based, Naturals, Wood, Chemical products, Textile, CDW Cement-based, etc.	textile
Composition 1	Major component composition, with %	60% Wool (WO) 40% Viscose (CV)
Composition 2	Minor component composition, with %, if any	100% wool (wo)
Composition 3	Minor component composition, with %, if any	80% Wool (WO) 20% Viscose (CV)
Contaminants		no
Size	Particle size and description	1 m ³ / bag
Containment	Storage/disposal form (bags, bottles, etc.)	bags
Location	Choose from the previous schedule (company - waste location)	9730 Kőszeg Rőti völgy 3.
Annual cost	The annual average cost for waste collection and disposal in €/y	Not particular cost
Properties		
Functional properties	Tough/brittle, stiff/flexible	flexible
Tactile properties	Hard/soft, smooth/coarse/texturized, warm/cold	soft, smooth, coarse, warm
Visual properties	Opaque/transparent, Solid colour, Gradient, Effects	solid colour
Odour	if any	like wool

If waste does not go to landfill the possible processes, methods or tools that can transform our waste are cold pressing/ deep drawing; die cutting; printing; stitching and thermoforming/compression moulding.



4. LCA of the textile waste covered by the pilot case

Environmental characteristics and environmental impact assessment of the pilot case waste

The interest in increased textile reuse and recycling is consistent with the increased attention given to the circular economy concept. ¹³ *Ellen MacArthur Foundation's circular economy system diagram* (2012, p.24) highlights the important role of reuse and recycling in a potential future circular economy. According to Ellen MacArthur “A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.”¹⁴

*In the textile/garment industry - as good practice - we mention Teemill, which is a tech-based fashion business having a holistic view of the fashion industry and designing out waste at each step of the material supply chain, applying disruptive technology to minimise overstocking, and maximise material recycling.*¹⁵

The European Federation of Waste Management and Environmental Services (FEAD) highlights potential EU action and the circular economy package as an opportunity to support secondary raw material markets. They recommend

- to support early movers using market tools such as lower rates of VAT on products that are second hand or are made from recycled materials;
- to extend producer responsibility schemes to operate transparently and further incentives manufacturers to design products differently.

4.1. Environmental characteristics

The main environmental effects of the company

Multifelt Factory uses wool as raw material. It produces environmentally consciously: they make the felt a) carbonising; b) willowing and dusting; c) carding; d) fulling; e) dyeing, ironing, shaving and pressing.

Wool felt is a natural product, made with a totally natural process with minimal chemical additives which make this product biodegradable and environment-friendly. It is recyclable, too! The processing of wool requires very little environmental impact compared to other natural fibres or man-made fibres. As wool felt is made of sheep's wool and viscous staple fibres, this means that after the felt product has been used or become worn out, it can be disposed of in an environmentally friendly manner. Multifelt's products have several certifications, which among others support their environmental consciousness too. The felts produced by Multifelt factory has been tested and certified to meet the human-ecological requirements of the standard presently established for products with direct contact to skin according to Product Class II of STANDARD 100 BY OEKO-TEX®. Multifelt Factory gained also

¹³ See it for example in the 2015 EU Circular Economy Action Plan ([EC, 2017](#)) but we can find this concern also in 11th five-year plan of China - a major producer of textile products - issued in 2006 ([Zhijun and Nailing \(2007\)](#)).

¹⁴ <https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy>

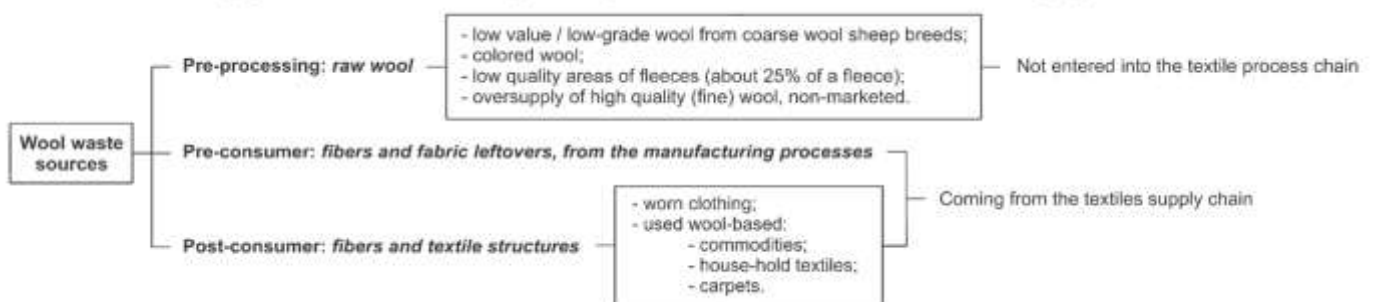
¹⁵ <https://www.ellenmacarthurfoundation.org/case-studies/an-open-access-circular-supply-chain-for-fashion>

several *quality certificates* like ISOLA Quality Certificate, Natural Quality Certificate and MERINO Quality Certificate. Merino Quality Certificate concerns the 'Merino' fleece made from 100% Hungarian, coloured wool; ISOLA and Natural fleeces are made from 100% white and coloured wool (see chapter 2.1.). Taking into consideration the use and re-use of 100% wool-felt we have to mention that Multifelt Factory Kft. has so-called *Declaration on flame retardancy* of its wool-felt and *Fireproof Certificate* from CHT Switzerland AG. This natural flame resistance property makes this material ideal for indoor applications like carpet, curtain, upholstery as it reduces the risk of spreading fire.

4.2. Environmental impact assessment

Wool wastes are classed as low risk. The European regulations EC Regulation 1069 (2009), and EU Regulation 142 (2011) are valid in their context. Rules are set concerning handling, treating and disposal, and transportation. Unless it is washed or disinfected, raw wool waste must be sent to incineration or landfilling specialized sites.

The classification of wool waste is:



(Source: Hossein, Rajabinejad - Ingrid-Ioana, Bucîşcanu - Stelian Sergiu, Maier (2018), p.1442, fig.5)

As concerns Multifelt factory, the source of their waste is “pre-consumer” fabric leftovers from the manufacturing processes.

The environmental impact assessment of the Multifelt factory concerns:

- the production (extraction) transportation, storage of the main raw material used in the factory, that is wool, and
- the manufacture, storage, use of their main product, felt, and
- the transport and disposal of their waste from felt.



Table 5 Environmental impact assessment

Process:															
Environmental impact	Energy consumption			Waste generation			Air pollution			Water pollution			Soil contamination / usage		Total
	Value of the stage	1 – Process or method with low energy consumption	2 – Average energy consumption	3 – Large consumption	1 – Little waste, no hazardous	2 – Average waste, no specially high volumes or risks	3 – High volumes, also hazardous waste	1 – No air pollution at this stage	2 – Some air pollution, but not considerably high	3 – Considerable air pollution	1 – No water pollution at the stage	2 – Some air pollution under control, (treated)	3 – The process often pollutes water, or high risk of that exists	1 – No potential to contaminate soil	
Stages	Before/After			Before/After			Before/After			Before/After			Before/After		
Extraction of resources	2/1			2/1			1/1			2/1			1/1		8/5
Transport of resources	2/1			2/1			2/2			1/1			1/1		8/6
Storage of resources	1/1			1/1			1/1			1/1			1/1		5/5
Manufacturing, assembly	2/2			2/1			1/1			2/1			1/1		8/6
Storage of finished products	1/1			1/1			1/1			1/1			1/1		5/5
Use, useful life	1/1			2/1			1/1			1/1			1/1		6/5
Waste transport	2/1			2/1			3/2			1/1			2/2		10/7
Waste disposal	2/2			2/2			3/3			2/2			2/2		11/11

4.3. Conclusions

What is the meaning behind these figures? Is the process concerning Multifelt Factory production is of slight, medium or large environmental impact?

The conclusion is that the production of wool felt has a low environmental impact. It is the same in case of wool felt waste reuse and recycling. The worst (major) environmental impact is presented during waste disposal if it is through incineration. In addition, the transport - including the transport of resources and waste transport - has major environmental impact, first in concern of air pollution, but lately has been also demonstrated that the tire wear particles (TWP), generated from tire material during use on roads contaminate the soil and also the water if road is near to it. As the waste of the wool felt, the reused wool felt or the products produced from recycled wool felt has similar inner characteristics as the original wool

felt, there is not high difference between the before and after values depending also on the quantity of the raw/reused material.

Wastes/product/process effects of the environment with and without the pilot case

The pilot case helps Multifelt Factory to reuse its waste and avoid the worst solution, which is incinerating not used waste. Multifelt has some small quantity of waste stored already long time in bags in warehouse, which may end as incinerated. This is the worst solution for the factory as it does not only pollute heavily the environment but also because not income can be realised from the valuable wool felt waste.

5. Identification of the companies in the partner region with similar waste streams

As we could previously see, the database OKIR includes data for textile waste according to the regions of Hungary but not by companies. We have not public statistics on main producers of industrial textile waste in Hungary. However, we can assume that the largest textile and garment producers are also the largest textile waste ‘producers’.

Table 6 Main textile producers in Hungary

Name of companies	Number of staff	Products
Lear Corporation Hungary Kft.	3000	Car seats and other products
Zoltek Zrt.	1.272	Carbon fibre
ADA Hungária Bútorgyár Kft.	713	Upholstered furniture
Aunde	354	Technical textiles
Sabina Zrt.	336	Car seats
TiszaTextil Műanyagfeldolgozó és Értékesítő Kft.	321	Big bags
Coats Magyarország Kft.	263	Industrial sewing thread
Propex Fabrics Magyarország Kft	252	Technical textiles for carpets
TOLNATEXT Fonalfeldolgozó és Műszakiszövet-gyártó Bt.	243	Technical textiles
Dunitalia Kft.	234	Spinning mill
Naturtex Kft.	151	Quilts and pillows
Glovita Zrt	127	Gloves
Hartjes-Biosoft Kft.	140	Footwear - vamp production
Mamutec Hungary Kft.	108	Technical textiles

Source: INNOVATEXT Zrt., based on www.ceginformacio.creditreform.hu / (2015)

Table 7 Main garment producers in Hungary



Name of the company	Number of staff	Products
Kézmű Közhasznú Nonprofit Kft.*	7000	Clothing and other products
Szegedi SZEFO Zrt.*	1,023	Clothing and other products
Felina Hungaria Kft.	602	Lingerie
Berwin Ruhagyár Zrt.	600	Clothing, suits
Maerz Fashion Kft.	421	Men's and ladies' wear
Calida	344	Lingerie
Rösch Mode Kft.	290	Fashion and technical textiles
Adorján-Tex Kft.**	262	Clothing for government institutes
Beriv Zrt.	193	Wom. dresses, pants, shirts, jackets
SH Rekord Ruhaipari Kft.	216	Clothing
Beanett Bt.	189	Workwear
Mey Hungaria	184	Lingerie
PI-ER Technical Kft.	180	Technical clothing
Kübler Hungary Kft.	165	Workwear
Umato Kötöttárugyártó Kft.	163	Knitted children's wear
EUROTEX Ipari és Szolgáltató Kft.	145	Flat knitted garments

- *Companies processing/recycling/reusing and selling recycled products from textile waste*

TEMAFORG Zrt. (Kunszentmiklós) (description see later)

TESA Kft. (Mohács), around 3000 t/year, production activities similar to in Temaforg Retextil Foundation

TANDEM Kneatwear, Fashion and Textile Waste Processing Company

Online portal for handicraft from recycled textiles - hellodiy.hu

Rethy Fashion - The designer offers a redesign of used and recycled denim - <https://rethy-fashion.com/>

- *Companies operating containers for sorted collecting of worn-clothes and textiles*

Textrade Kft. (Székesfehérvár) main retail company for textile waste: around 40000 t/year (5 machine lines for sorting of imported used clothes from European countries, 300 employees)

ReFoMix Nonprofit Közhasznú Kft.

Easyget Kft. importing and selling used clothes from the UK

Rakoczi Kft importing and selling used cloth from the UK

- *Cluster operating in T&C sector*

Pannon Textile and Clothing Cluster



Although only Multifelt Factory produces felt, there are several companies in Hungary, which deal with wool both from point of view of production and sale and/ or producing non-woven textile and product.

Existing companies dealing with non-woven textile and/or wool in Hungary and with similar waste

- *Identification of the companies in the partner region with similar waste streams - non-woven textile*

As Multifelt Factory is the only felt factory in Hungary, it is the only company producing waste from felt. As concern non-woven textile, *Lőrinci Textil industrial Company* started to produce it in 1959 until the closing of the factory in 2004, using maliwatt¹⁶ technology.

Temaforog Kunszentmiklós Ltd.

Today, *Temaforog Kunszentmiklós Ltd.* produces non-woven textile in a significant quantity (4-5000 tons/year) for making geotextiles, furniture padding, clothing linings, industrial wipes, filters and ironing board pads. In addition to regular raw materials, the factory uses significant amount of secondary (waste) materials too.

J.H. Ziegler Hungary Ltd

Ziegler is one of the world's leading manufacturer of non-woven textiles, the J.H. Ziegler Hungary Ltd. produces non-woven textile for industrial purposes because of their sound and heat insulating properties and good air permeability, among others for the use in car industry. In the Hungarian factory in Bábolna, Ziegler employs around 140 persons.

Top textile Ltd

Top textile Ltd was founded in 1995 produces non-woven fusible and non-fusible interlining (spin vlies, spun-bond, etc.).

- *Companies dealing with production/sale of wool - they are only very few*

Kaschmir-Gold Kft.

NATURTEX Gyapjú- és Tollfeldolgozó Kft.

Swiss-Woll Kft. (mainly importing wool-based mattresses and sheets)

We have to note that according to the Hungarian National Directory of Companies a vast number of companies with similar profile ceased to exist during the last several years or are actually under liquidation like Richardson.

It is a big problem from the point of view of the Hungarian wool processing that at the end of 2003 the last wool washing company was closed (Gyapjúmosó Kft. in Nyiregyháza). The wool is

¹⁶ The Maliwatt machine interlaces a web of fibres with a sewing thread giving the effect of parallel seams.



first shipped to countries like Italy, Germany, Austria, etc.. Only some of the already processed wool returns to Hungary for further elaboration.

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