MATERIAL RECOGNITION_TEXID PROJECT

SORTING FOR RECYCLING AT SOEX / I:CO

Project supported by

Re_fashion

I:CO SOEX

CONTEXT / OBJECTIVES

MAIN CHALLENGES

KEY ACHIEVEMENTS

CONCLUSION / FUTURE DEVELOPMENTS

CONTEXT / OBJECTIVES

PILOT SORTING STATION

- The pilot textile identification machine was developed and set up as **part of a 3-year project** called **RESYNTEX funded by the European Commission.**

- Key features:
  - Simple conveyer belt – manual feeding
  - 1 NIR spectrometer with RGB sensor
  - Manual operation and sorting
  - Sorting capacity: up to 100 kg / hour
  - Material recognition technology with 64 sensor points

- **Launch of TEXID (Textile Identification) Project – July 2021**
  - 2 year project supported by **French EPR** organization **REFASHION**
  - Goal – Scaling the pilot material recognition machine to industrial scale.

PILOT SORTING STATION

CONTEXT / OBJECTIVES

FULLY AUTOMATED MATERIAL RECOGNITION

- **Fully automated sorting** operational since May 2022

- Key features :
  - 1 conveyer belt
  - NIR spectrometer with RGB sensor
  - Sorting capacity: up to 700 kg per hour
  - Automatic feeding and garment separation by picking up to 1.500 pieces per hour (depending on the size and weight of the piece)
  - Material recognition technology using 15 sensor points
  - Identification of 86 different material compositions (natural fibers / synthetic / blends)

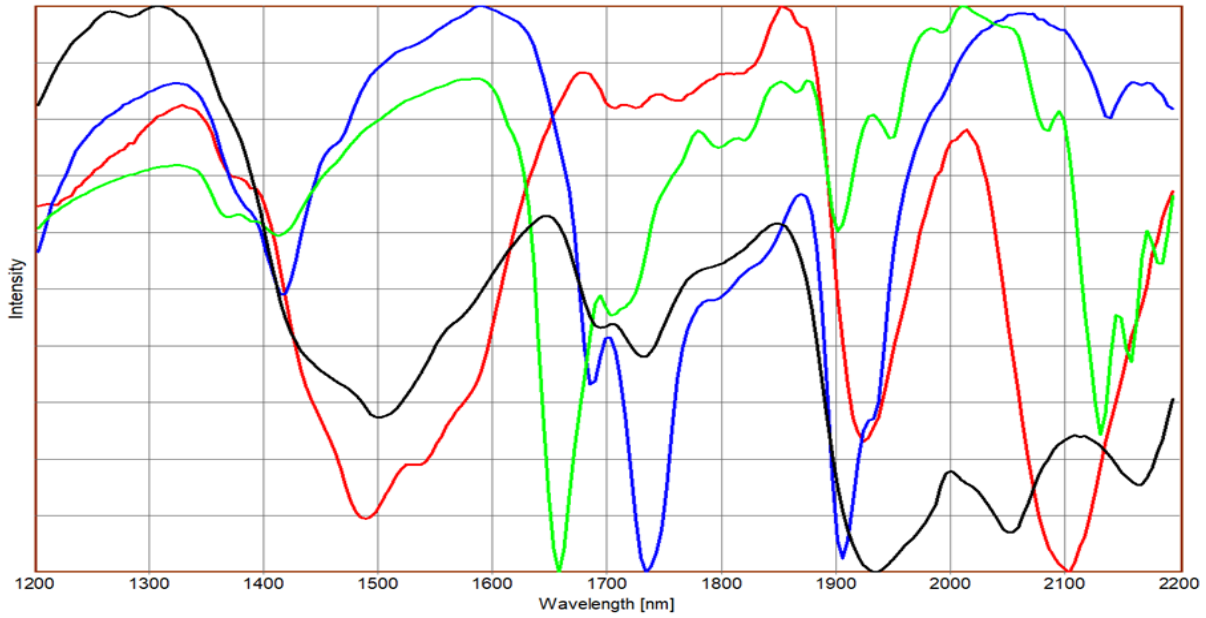
- **Integration** of the line into the sorting and production process
- Establishment of an **infrastructure / processes** for recycling of textile waste
- **Training** of employees

CONTEXT / OBJECTIVES

MATERIAL RECOGNITION – NIR SPECTROSCOPY

HOW IT WORKS

- Physical method for the **determination of organic molecular bonds**
- Operates with light of a wavelength of between 800 and 2.500 nanometers - this makes it lie between the visible spectral range (VIS) and middle infrared (MIR)
- **When the NIR radiation is absorbed by the textile, it causes vibration in the molecules**
- Information about the molecular structure can be taken from the reflected spectra (“fingerprint”)
- **Each material or material composition shows different modes of vibration**



Cotton
Polyester
Polyacrylic
Wool

NIR REFLECTANCE SPECTRA
OF DIFFERENT MATERIALS

MAIN CHALLENGES

MATERIALS	• **Heterogeneity of the material flow and sizes coming from the fashion industry (post consumer textile waste)** • **Carbon-containing pigments** make the NIR detection of material composition impossible, as it absorbs infrared radiation. • **Multilayer textiles** as only the surface of the textile is being scanned. For example, if the outer layer is cotton and the lining is polyester, the result will be different depending on how the garment lays on the conveyer belt. The result of the material analysis can be influenced by **metals, coatings or finishes.** • **Elastane** – only detected if there is more than 3-5%. Elastane is often not detected at all if it is spun inside the yarn / woven inside the fabric (not detectable on the surface). • Linen cannot be differentiated from cotton as they are both made of cellulose; PA 6 / PA 6.6 differentiation.
OUTPUT QUALITY	• There is **always a small percentage of impurities** due to prints, labels, seams, pocket linings etc. • Meeting the needs of chemical recyclers (high purity, light colors) is very challenging – • **The post-consumer input "purity" is insufficient for some chemical recyclers requirements.**
TECHNICAL LIMITS	• **Heavy textiles** cannot be handled by the picker and cause the system to shut down. • **Very small pieces** are also difficult to pick and slow down the process • Integration of external RGB Cameras for **color recognition** has been a challenge due to technical issues • Technical defects faced during field test & production • **"Textile Bundles"** : e.g. jeans and knitwear become entangled in each other in the container and form bundle after being tipped out into the conveyor belt.

Generally speaking, there is always the need to compromise between quantity and quality of the sorted fraction. Setting stricter thresholds will improve purity, but decrease quantity (and vice versa). Therefore, the intended application of the output needs to be considered and monitored in close collaboration with partners/ recyclers.

KEY ACHIEVEMENTS

- **Scaling production capacity** from the pilot setup **(50 kg / h)** to a **fully automated, resource-efficient** and integrated setup **(up to 700 kg /h)**
- **Combination of different technologies** from different manufacturers into a functioning machine.
- Implementation of a **fully automatic** system (feeding, sorting and ejection).
- **Already sorting according to recycler specifications and customer requirements since June 2022** (such as cotton, polyester, CO / PES blends ranging from 20 / 80 to 80 / 20, Polyamide…)
- **Integration** of the automated material recognition into the sorting processes
- **Building up a feedstock for recycling** according to the market demand
- **Process optimization through pre-sorting:** removing items that interfere with the machine efficiency
- **Differentiating 86 different compositions** including different blends and color recognition.
- **Modular system right at the design phase** to anticipate the requirements of recyclers and future improvements of the line

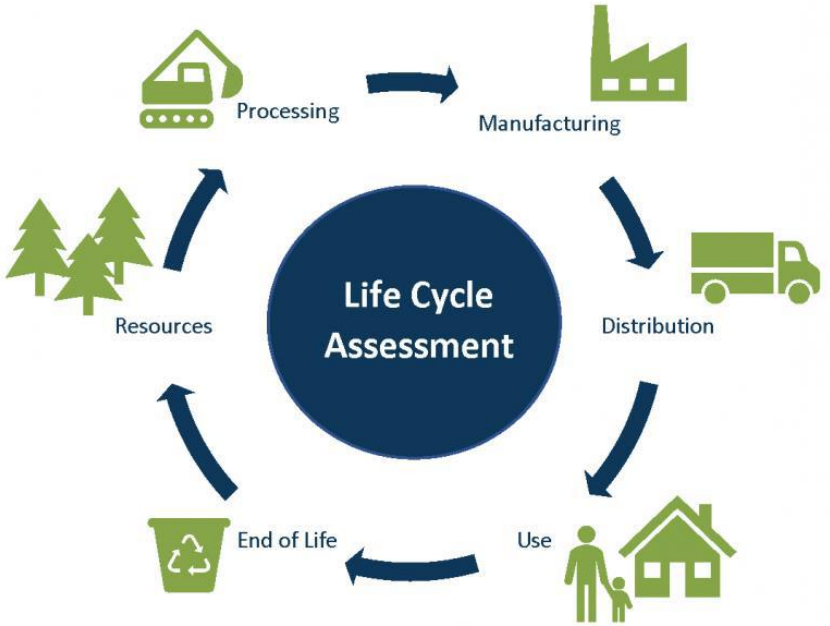
KEY ACHIEVEMENTS "GRAVE TO GATE " LIFE CYCLE ASSESSMENT

CONTEXT OF THE STUDY

LCA (Life Cycle Assessment) has been done on three scenarios, an 'Incineration Scenario' and two textile recycling scenarios: 'Traditional Scenario' (SOEX without automatic material recognition) and 'TEXID Scenario' (SOEX textile recycling value chain with NIR sorting). LCA consists of quantifying the environmental impacts of all the activities related to SOEX services.

LCA RESULTS

- LCA confirms the recycling of textiles at the end of their life is to be preferred to their incineration (with energy recovery). LCA has shown a real environmental benefit given to recycling. It also shows that making effort to separate materials results in mono materials (cotton, polyester, nylon, wool, etc) results in higher credits. i.e. being able to use the materials to make yarn to replace virgin wool or cotton.
- The figures below show the potential environmental "grave-to-gate" impacts calculated using EF3.0 (Environmental Footprint 3.0) method and System expansion model.



	EF 3.0 Climate Change - total [kg CO2 eq.]	EF 3.0 Acidification [Mole of H+ eq.]	EF 3.0 Eutrophication, freshwater [kg P eq.]	EF 3.0 Resource use, fossils [MJ]	EF 3.0 Resource use, mineral and metals [kg Sb eq.]	EF 3.0 Particulate matter [Disease incidences]	Single Score [EF3.0]
Incineration	152,40	5,92E-01	3,18E-04	878,66	2,97E-06	3,26E-06	**8,91E-03**
Traditional Scenario	-234,14	-6,22E-03	-2,32E-03	-7711,38	-1,02E-03	1,83E-06	**-2,19E-02**
TEXID Scenario	-280,11	-2,73E-01	-3,30E-03	-7385,18	-8,83E-04	-2,58E-06	**-2,62E-02**

LCI Impact results using EF3.0 in Sphera LCA for Experts

LCA practitioner:

AIR COOP
COOPÉRATIVE D'ENTREPRENEUR·E·S DU CHANGEMENT

CONCLUSION / FUTURE DEVELOPMENTS

CURRENTLY & NEXT STEPS

- **Further investment** to **meet the challenges** mentioned above, to **improve the quality** of the output and **ensure a profitable, high-quality secondary raw material**
- The **sorting system is modular in design** and is **being expanded with additional discharge chutes** which will allow us to effectively separate more material compositions & colors.
- **Combining different technologies** to complete the NIR
- **Color sorting** – currently training the machine to recognize the first colors (red, blue, white and green) to start building a portfolio of material composition and color composition
- **Garment/Shape recognition** – training the machine to recognize certain types of garments / items of clothing (potential application in sorting for re-use)
- Continue to assess each cases and development with further LCA's to **make sure of the environmental benefits and impacts** enabled thanks to the automatic sorting for recycling.

LET'S
JOIN
FORCES!

Let's get in touch & discuss possibilities to move towards a more circular fashion !

SOEX TVG
& I COLLECT GMBH

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