

## FOOTWEAR WORKSHOP SUMMARY NOTE

The recycling of footwear: disassembly, transformation and outlets for recycled raw materials.

December 2022



### Recycle Re\_fashion

The purpose of the Refashion Recycle platform is to enable textile industry stakeholders to contact each other in order to facilitate and accelerate the industrialisation of non-reusable clothing and footwear recycling. Through its workshops and webinars, Refashion is building bridges between companies that offer materials and industrials that will incorporate them into their production processes.

## Increasing the collection of used footwear is structuring for the industry

The primary challenge raised by all, is the necessity to increase the tonnages of footwear collected. Both sorting operators (the main entities in possession of used footwear sources) and marketers initiating specific collection operations, experience difficulties in collecting footwear massively despite an identified collection network and suitable communication. This trend is seen and shared by Refashion. Below is a reminder of a few significant key figures.

In 2021, 715,000 tonnes of textiles and footwear were placed onto the markets. Only a third was deposited in one of the 45,000 self-deposit banks (SDB) in France, the remaining two thirds are stored in cupboards or finish up in bins. This is particularly true for footwear which only accounts for 7% of sorted tonnages, i.e. 13,300 tonnes, whereas they represent 18% of the tonnages placed on the market. In addition, the large majority of consumers **deposit footwear that is actually in a “good state” and which could be reused into SDBs, and throw away worn out shoes.** This is why nearly 90% of the footwear collected is eligible for reuse (mainly sold for export), compared to only 55% for clothing<sup>1</sup>.

Bulking for collection is an issue that needs to be addressed in the same way as the identification of components, the preparation of footwear for recycling, the separation of materials and the incorporation of these in new products. This is shown in the diagram below.

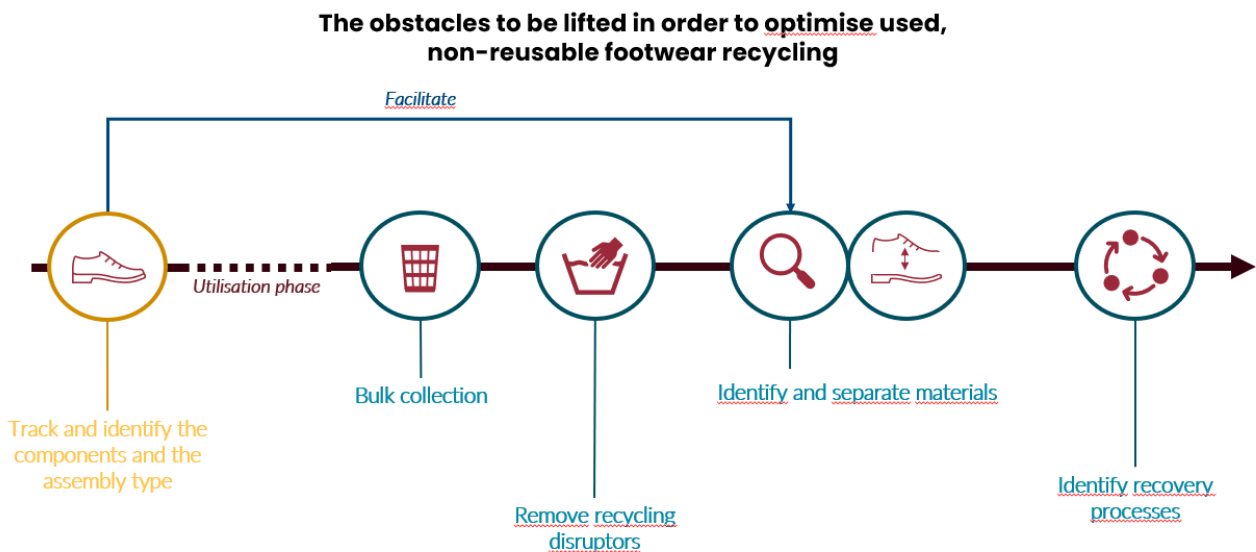


Figure 1: The stages identified as obstacles in the development of used, non-reusable footwear recycling during the Footwear workshop.

<sup>1</sup> The Future of Used Clothing and Footwear, pages 14 and 15 - [Magazine Innovation #11 de Refashion](#)

## Each recycling process requires the preparation of footwear

Today, the reality in used footwear recycling is quite stark: there are still not enough recycling solutions<sup>2</sup> compared to clothing<sup>3</sup> and for which industrial-scale projects are beginning to emerge. To start with, remember that it is important to raise consumer awareness about the durability of products they buy and on the good “conduct” to be adopted in terms of their footwear. Postponing as far as possible the end-of-service life of footwear is achieved through care and repair. Once its real end-of-service life has been reached, recycling appears necessary.

The recycling experiments and projects performed over the last few years have brought to light two separation methods.

- In the first instance, the main parts of footwear are separated (outer sole, inner sole and upper shoe) then the different components of these parts are extracted. This is the method used by the Eram Group in the *Zapateko II* project, partly funded by Refashion within the context of its annual call for project proposals, the Innovation Challenge<sup>4</sup>. Separation is performed by tearing apart the upper shoe from the sole after the footwear’s model has been identified using artificial intelligence (AI);
- The second method used for separating the components of footwear is its entire shredding then separation of the components using complex treatment processes, generally densitometric processes. This process has been developed in particular in the *Footwear Recycling Project*, managed by the AIR Coop Agency and the SOEX sorting centre and co-funded by Refashion within the context of the Innovation Challenge.

Discussions also highlighted the need to clean and sometimes disinfect footwear before recycling operations. The presence of gravel, sand, dust etc. in the soles of used footwear may damage machinery and cause deterioration of the products produced from recycling. Therefore, this stage requires special attention especially as it is often carried out manually and not industrially.

## Determining a product’s identity to send it to a suitable disassembly process

To improve the footwear component separation stages and improve component recovery, it is essential to identify footwear models and to know their composition (and if necessary, even the colour). Remember that many materials and assembly processes are used during footwear manufacture. There are up to 40 different materials in the manufacture of footwear and these themselves are comprised of an average of 5 different materials either glued or sewn together, making it difficult to disassemble them.

### The use of AI to identify products

The *IDS*Shoes project managed by the Eram Group with CETIA has enabled an identification technology for footwear models to be implemented using an artificial intelligence system and a database fed by Eram and Decathlon marketers. The project’s results are promising in that this technology enables a 98% identification rate for the 500 models used in the test phase. This process can be scaled up by including other marketers in the database. Also, it is interesting to underline that this solution seems relatively simple to put in place as it only requires a belt drive, a few cameras and a computer for the IA to function.

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<sup>2</sup> [The Future of Used Footwear map](#) - Refashion

<sup>3</sup> [Map of products made from recycled used textiles](#) - Refashion

<sup>4</sup> [Panorama of projects funded by Refashion](#) since 2010 within the Innovation Challenge programme. Refashion

## Direct identification of the product

Other identification methods for identifying footwear components can be considered. The integration of chemical markers specific to each component was cited as it is already performed on plastic items such as PET bottles. A real example in the case of footwear is the stamp mark system used by the manufacturer, Humeau Beaupréau, for boots. It enables the brand, the model and its composition to be identified and the used footwear to be sent to the level of separation required.

## A materials passport

In all cases, it seems appropriate to move towards the standardisation and implementation of a general materials passport for footwear. This would allow treatment processes in sorting centres to be standardised. This approach is even more important given that the current technologies to identify components, essentially by spectroscopy, only identify the components on the surface and not volumetrically.

## The outlets: level of purity and quantities required

Some companies underline the difficulty in finding clients for recycled raw materials (RRM) that result from the different processes. Bulking this is without doubt an obstacle that must be overcome. No quantity range was put forward but the stakeholders all agree that transformation and/or recycling operators require significant minimum quantities in order to undertake tests and then scale up to an industrial level.

## Work based on specifications

Even if the aforementioned projects demonstrated technical feasibility, currently no industrial solution to incorporate RRM exists. It is therefore essential to identify outlets and specifications corresponding to the integration of RRM in both open and closed (into new footwear) loops. The diagram below ranks the materials according to their maturity in terms of outlets.

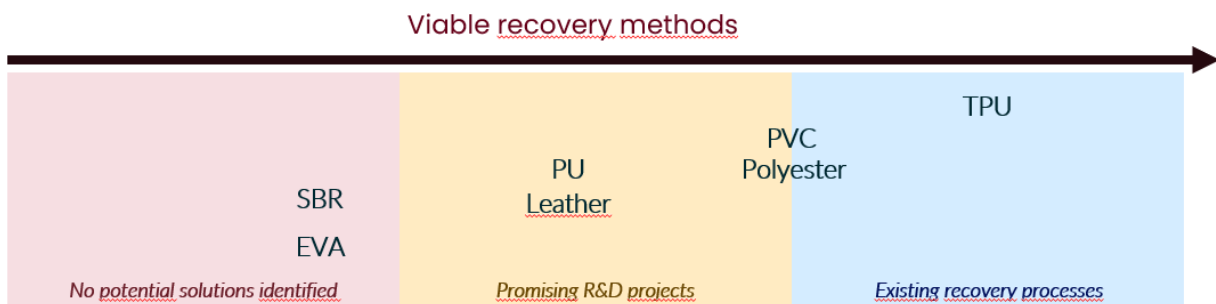


Figure 2: Progress in recovery methods according to footwear components

- TPU: recovery methods exist and seem to work for this material as pointed out by two companies. Salomon reincorporates this material in ski boot design through an internal process. Revalorem implements recovery systems for its clients;
- Polyester (PES): Salomon pointed out that this is a material that recycles very well, even when it comes from textiles, so long as pollutant content in the material is less than 10%. Current processes are varied: mechanical, chemical and enzyme-based recycling. Products whose quality is average or equal to that of virgin polyester can be obtained from these processes.

However, a significant volume of material has to be recovered before it can be sent to a recovery treatment process.

- PVC: Humeau Beaupreau pointed out that recycling PVC and its reintegration in production (shredding then reinjection) is quite simple when it comes from production waste. No alteration in the material has been observed up to its 7th life, even by using 100% internal, pre-consumed material. However, for PVC coming from a post-consumer source (presence of phthalates in products manufactured before the enforcement of the REACH regulations) it is not known at this stage if difficulties could arise during its 2nd or 3rd cycle. It could, therefore, be more complicated to incorporate 100% of this post-consumer material in new boots;
- PU and leather: Revalorem pointed out that they have not yet found sustainable recovery methods for these products. However, R&D work has enabled potential promising recovery methods to be identified;
- SBR and EVA: Revalorem pointed out that no sustainable recovery methods exist for these components. Additional work must be carried out.

*Recovery methods for rubber were not discussed during the workshop.*

**The sought-after outlets also significantly determine the level of separation to be implemented:** rough separation is sufficient for downcycling uses, i.e. use in non-original applications, e.g., sports ground surfaces, soles of footwear, etc. and that can tolerate a certain level of variability and impurity in the materials obtained. Their specifications are more flexible in particular in terms of material purity.

However, more advanced separation is essential if more interesting outlets from an economical point of view, in particular leather and rubber recycling, are to be found. Indeed, Revalorem's customer specifications **often require minimum closed loop reintegration of 95% or even 99%**.

Another company also pointed out that constraints linked to the **different material grades**, restrict the incorporation of recycled materials in products other than footwear. In this sense, the reincorporation of material from soles into new soles seems to be one of the best recovery methods possible because it enables the same material grade to be kept. Consequently, the reincorporation in new soles, even a small amount, is in itself already a step forward in itself.

## Going further

### Brainstorming on footwear typology

To find practical solutions for these challenges it appears necessary to treat the subject by type of footwear. Not all footwear has the same characteristics, whether in terms of composition or assembly. Thereby, not all footwear requires the same separation or recycling processes. For example, it is more difficult to separate sports footwear components through tearing apart than those for everyday footwear. Working per typology will allow more specific issues to be highlighted.

### Bulking and knowledge about the footwear

To improve the search for and the development of different recovery methods the issue of pooling footwear was addressed. The reason being to pool sources and to be able to initiate serious discussions with recycling operators.

Furthermore, better knowledge of the type of footwear entering sorting centres is necessary in order to know their amounts and thereby identify priority areas of work. The eco-organisation is undertaking a characterisation study of incoming and outgoing streams in sorting centres which will be published in spring 2023.

### Achieving financial profitability

Financial aspects are always important in the decisions made in footwear recycling. Indeed, the development of recycling solutions is being hampered by a lack of identified companies interested in incorporating RRM. In addition, some companies, in particular in the luxury goods industry, do not want materials coming from their products being incorporated into downcycling processes, which to date are the most developed. To meet this need, longer more complex recycling processes need to be implemented. This will have the direct affect of increasing recycling costs.

#### Areas of work in order to improve footwear recycling

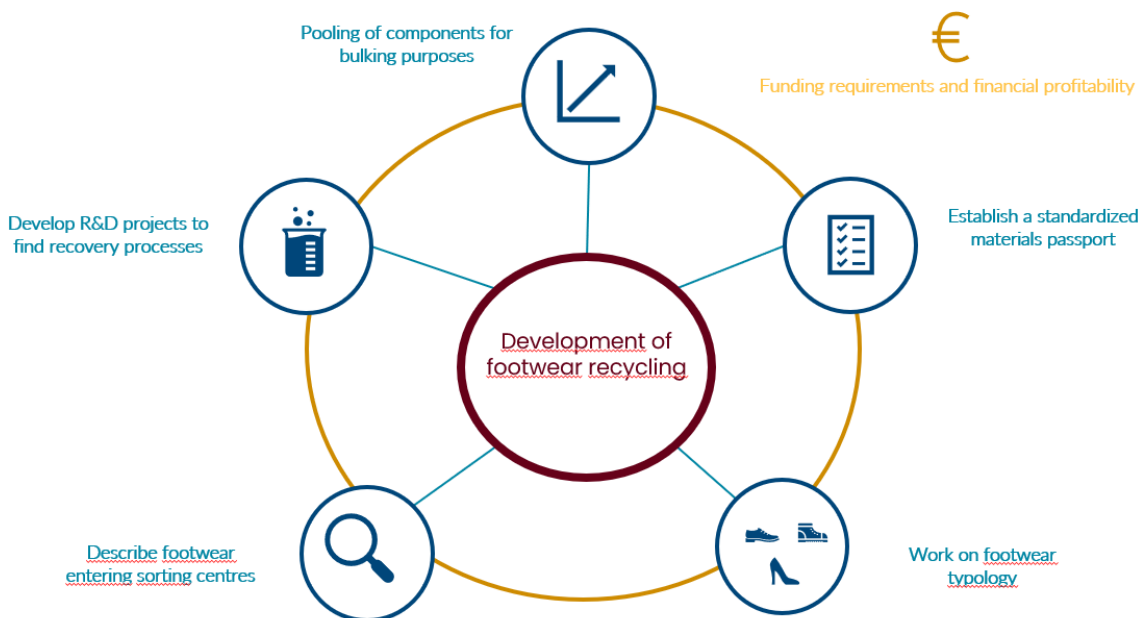


Figure 3: Areas identified during the Footwear workshop to continue working on footwear recycling.