EXPERIMENTATION ASSESSMENT OF AIR-SOEX PROJECT

FOOTWEAR ECO-DESIGN GUIDELINES TO IMPROVE RECYCLABILITY

v1.0 - March 2018

SOEX FOOTWEAR RECYCLING PILOT

AIR AGENCE INNOVATION RESPONSABLE

In-Cycle Keeping materials in production cycles

SOEX GROUP

CONTENT

1. CONTEXT & OBJECTIVES

Long before starting the footwear recycling pilot line at SOEX, pioneers already looked at how to recycle shoes.

Nike was the first organization (1992) to implement a large scale shoe recycling solution, but the approach was dedicated to sport shoes only.
Since 2007, Loughborough University (where Dr. Mike Lee worked for several years) has also experimented various technologies to separate the different materials in shoes.
Through their knowledge of footwear recycling technologies, both organizations have explored the possibilities to improve the recyclability of shoes by giving guidelines to designers, engineers and brands. Nike has clearly made a step forward with the creation of their internal Material Sustainability Index and the implementation of technology like the Flyknit. Small brands follow. Like Ector for example.

However, there is no clear guidelines currently available for shoe designers or brands to improve the recyclability of shoe waste. This is the ambition of this document, based on our 3 years experience running a footwear recycling pilot line in Germany.

N.B. This is the first edition of these guidelines. We aim at improving it over the years. Thus, do not hesitate to share your feedback and suggestions to make it better and help the footwear industry to reduce its impact on the planet.

2. MAJORS CHALLENGES

The major challenges currently faced at the SOEX footwear recycling line :

1. **Non ferrous metal** pieces contaminating in the output
2. **Solid plastic** pieces contaminating in the output (e.g. Women's heels)
3. **Variety and mixture of materials** used in the footwear industry
4. **Materials characterization**
5. Contamination with **electronic components**
6. Contamination with **non compliance chemicals** (ex. PAH)

2. MAJORS CHALLENGES

1. Non-ferrous metal pieces contaminating in the output

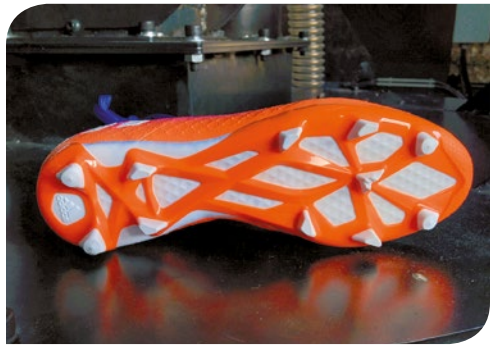
Even though a 'detect and eject' metal separation machine is installed and is able to successfully remove non-ferrous metal, (e.g. aluminum eyelet) there is still some metal contamination of the recycled output.
Furthermore, good rubber is also rejected alongside the small metal pieces, meaning the overall yield of good material is reduced.

2. MAJORS CHALLENGES

2. Solid plastic pieces contaminating in the output

Certain shoes, like women's high heel shoes, have a high percentage of leather uppers, but also a large quantity of plastic in the heel. Some complex sports shoes also have leather uppers but have plastic integrated as reinforcement (heel, eyelet, etc.).

After being shredded, these solid plastic pieces go through the recycling process but are difficult to separate.
For example, some pieces of solid plastic have been found in the rubber output of recycled sports shoes.



2. MAJORS CHALLENGES

3. Variety and mixture of materials used in the footwear industry

Footwear products are a complex product with over 40 different types of materials being used to produce them, making recycling an extremely challenging problem. Furthermore, there are many highly complex shoes (e.g. sports shoes and winter boots) that use an increasing high mixture of materials within the same shoe, which ultimately means it is difficult to obtain high purity recycled outputs.

©Nike

2. MAJORS CHALLENGES

4. Materials characterization

Through visual examination of a worn pair of shoes it extremely difficult to identify the type of materials being used. For example, real leather and synthetic leather is impossible to visually distinguish (without being cut open and further examined).

For rubber it is also impossible to visually distinguish the extract material type. Even NIR based sorting technology would be largely ineffective as the technology struggles to identify materials that are black in colour (the majority of shoe soles).

2. MAJORS CHALLENGES

5. Contamination with electronic components

The use of electronics in footwear is increasing: with Internet Of Things (IOT) and interconnected devices the trend is booming.
For example, sensors are now integrated in the outsole or innersole to allow consumers tracking their physical activity. Of course, due to the electronic components, these shoe materials need another type of sorting/recycling and currently can not be recycled through the SOEX Footwear Recycling Pilot Line.

2. MAJORS CHALLENGES

6. Contamination with non compliance chemicals

Collecting, sorting and material recycling of all types of shoes in Europe can be problematic when it comes to chemical compliance. Indeed, some of the shoes collected could have originated from a diverse range of countries and may have been produced many years ago. A number of collected shoes can even be in excess of 20 years old, produced way before chemical regulations like REACH were in place.

3. OUR RECOMMENDATIONS

Based on our tests & experiments with the pilot line, we have been able to define some key recommendations to improve shoes recyclability:

1. **Reduce the use of metallic parts**
2. **Limit the use of solid plastic parts**
3. **Limit the mixture of different material types**
4. **Consider the material density**
5. **Reduce the use of adhesives** where possible
6. **Labelling of the main material types**
7. **Avoid non removable electronics components**

N.B. Before designing shoes to improve recyclability, shoes should be designed to be durable and repairable so they last as long as possible.

3. OUR RECOMMENDATIONS

1. Reduce the use of metallic parts

If metallic parts are used, ferrous metal is preferred

If footwear products contained no metal parts then the overall recycling process would be simpler and there would be less risk of metal contamination in the recycled materials outputs (which significant lowers its value and end-use potential).
If designers must use metal then a ferrous based metal (magnetic) is preferred as these types of metals are easy to remove during the recycling process.
Another option is to reinforce the eyelets with a PU coated piece which allow the removal of plastic or aluminium.

Example of metal free footwear: ©Nike Flyknit

Example of ferrous metal used for eyelet

3. OUR RECOMMENDATIONS

2. Limit the use of solid plastic pieces

Much the same as the use of metal parts, in the long term if footwear products contain no solid plastics parts then the recycling process will be simpler with less risk of contamination (e.g. hard, sharp, plastic parts in rubber output can cause problems for final use applications, like matts and playground surfacing). Thus, designers are encouraged to remove all solid plastics parts (in eyelet, shank, reinforcement, etc.).

Example of ferrous metal shank

Example of heel shoes without solid plastic: ©Timberland

3. OUR RECOMMENDATIONS

3. Limit the mixture of different material types

The large number of different materials used in the manufacture of footwear products makes it difficult to reclaim high purity recycled materials. For example, recycled shoe rubber output will contain a variety of different material types, both thermoplastic elastomers and vulcanised rubbers. One solution is of course to pre-sort the type of footwear that enter into the recycling line (rubber outsole, leather upper, sports shoes, etc.) but a high variety of materials is still found among those categories.Thus, designing the future generations of shoes with a reduced sub-set of materials types could then improve the possibilities of reclaiming higher quality recycled output.

Example of simple design and construction: ©Ector

Example of simple design construction and transparency about material types (leather focus): ©Ekn

3. OUR RECOMMENDATIONS

4. Consider the material density

Effective density/air based separation (that is in use at the SOEX Footwear Recycling line) is dependent upon a density difference between target materials. For example to separate the rubbers from the leathers.
Shoe designers should thus consider the density difference between the different footwear materials. For example, for leather shoes, specifying a high density rubber for the outsole (solid rubber rather than foamed rubber) will help create a suitable density difference between the rubber sole and the leather, thus enabling effective separation.

Example of high density rubber sole with leather upper

3. OUR RECOMMENDATIONS

5. Reduce the use of adhesives where possible

Heavy use of adhesives to join footwear components can reduce the materials reclaim purity during the separation process – due to different types of material still being stuck together. Stitching of parts is recommended where possible. For example, in leather based shoes, stitching of the leather upper to the rubber sole will improve materials liberation because the stitching can be broken down during the recycling process, reducing the amount of leather and rubber particles joined together. If adhesives are used prefer bio-based and biodegradable glues. Welded seams can be great alternatives to glue if the welded materials are from the same family.

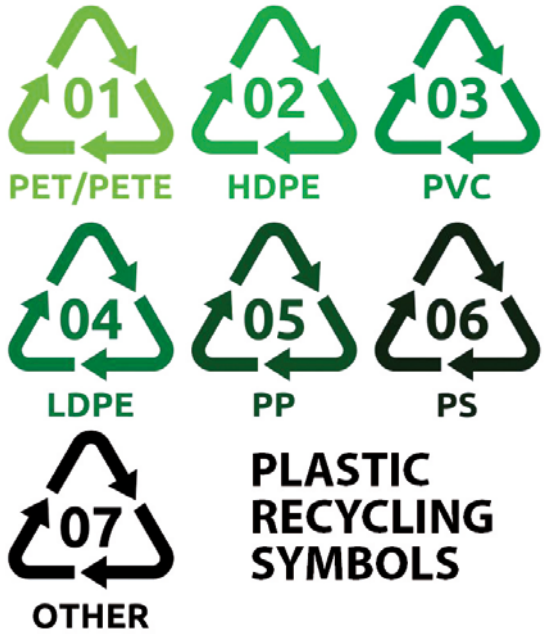
Example of Goodyear welted shoes: ©Paraboot

Example of easy disassemble shoe: ©LYF
(no glue at all)

3. OUR RECOMMENDATIONS

6. Labelling of main material types

The lack of material information on footwear products makes it difficult to obtain high purity recycled materials using current mechanical recycling technologies.
A simple material labelling system could enable shoes to be recycled into specific batches based upon their primary materials types. For example, sorting of shoes based upon different types of sole rubber could significantly increase the market value of rubber output. Shoes could include materials information in numerous ways. For example, a simple recycling symbol (like with plastic recycling) could be stamped on the heel arch of shoe sole to identify the type of rubber. Or natural leather could be better identified in the same way through a pictorial symbol that is easily visible for recyclers.



Example of plastic recycling symbols

3. OUR RECOMMENDATIONS

7. Avoid non removable electronics components

Electronic components can contain hazardous components that need specialized recycling technology.
One simple solution is to make these electronics integrated into a small module (attached to insole for example) that can be easily removed by the consumer prior to disposal. However, currently, the electronics tends to be fully embedded into the shoe products (see Under Armor Speedform Record Equiped), which will present many problems for future footwear recycling.

Example easily removable electronic inner sole: ©FeetMe

4. RESOURCES

Websites and articles helping designers to make more sustainable choices:

- www.bettershoes.org
- www.thesustainableangle.org
- Nike Making App
- Materials Sustainability Index (MSI)
- SMART (2007)

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Footwear brands considering shoe recyclability:

- LYF Shoes
- Po-zu
- Ector sneakers (knit Made in France)
- Puma In Cycle Collection (Biodegradable)
- Nike (Flyknit)
- Timberland Earthkeeper
- Bio-Knit Trainers (student project)
- Urshuz (closed apparently)
- OAT (Biodegradable)

Materials & process that contribute to footwear recyclability:

- www.plusfoam.com
- www.wet-green.com (C2C certified)

PROJECT SUPPORTED BY:

ECO TLC
L'éco-organisme du textile • du linge • de la chaussure