



Standfor patented shoes developed and produced by SOZÉ under the FASCOM project. CREDIT: SOZÉ

A circular economy for footwear

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Footwear consumers, producers and allied trade businesses could all benefit by moving away from the current linear economic model of take-make-consume-dispose, one based on the idea that resources are abundant, easy to obtain and cheap to dispose of. Instead, we should consider an alternative circular model in which the planet's environmental boundaries are respected by conserving resources and maximising the use of all resources.

This circular model involves increasing the use of renewable or recyclable resources while reducing the consumption of raw materials and energy, and, at the same time, decreasing emissions and material losses. The overall aim is to manage all resources efficiently and sustainably.

As far as footwear is concerned, eco-design, resource efficiency, waste

prevention, waste recycling and management, and new business models are, among other considerations, important in a circular economy. These various aspects can all play a relevant role in maintaining the usefulness and value of the materials and products in that economy, contributing to effective resource management and sustainable development going forward.

Different concepts and visualisations of a circular footwear economy can be demonstrated in a simplified model (Figure 1). The main idea is that materials inputs and waste generation are minimised through good design, efficient production, distribution, use and recycling, to create positive economic and environmental benefits, so reducing resource extraction and overall emissions.

The outermost layer in the diagram represents overall energy contribu-

tions. In footwear, important issues to address include total energy efficiency and increasing the share of renewables involved.

The middle circle shows the materials flow in the recycling loop, including biological (e.g. leather) and abiotic (e.g. metals, minerals) materials. In principle, increasing the first is beneficial, as they can be said to be 'truly', renewable. Where footwear is concerned, different types of materials are frequently mixed, which has adverse implications in terms of biodegradability and/or recycling. Mixing can, however, be minimised during design and production processes.

The innermost circle represents the so called '5Rs'; repair, reuse, redistribution, re-manufacture and/or refurbishment, as applicable. These can all contribute to by-pass waste generation recycling, and therefore reducing resources input.

Figure 1 – The circular concept.

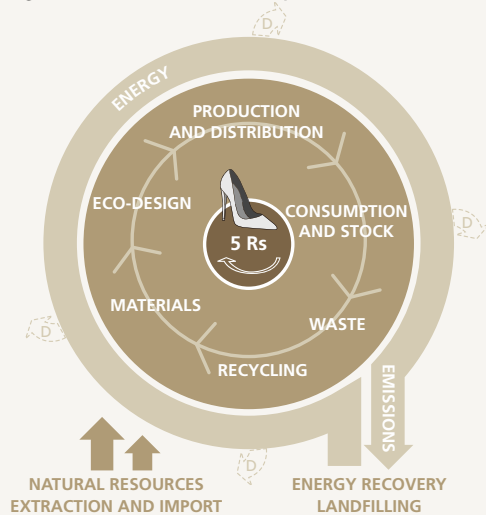
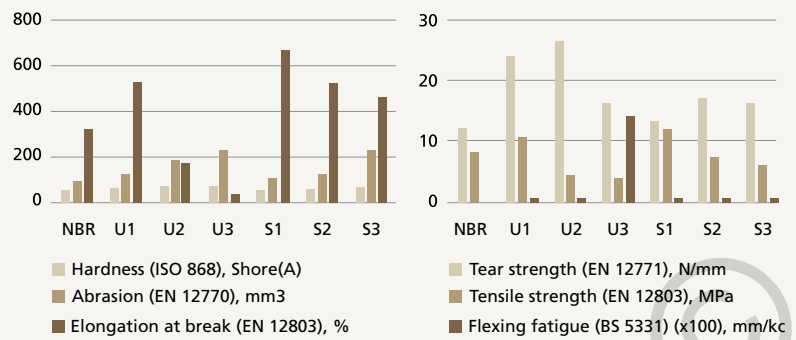


Figure 2 – Physical properties of NBR incorporating roughing waste.



Key:

NBR (acrylonitrile butadiene rubber)

U (upper dust composite),

S (sole dust composite),

1, 2, 3 correspond to 20, 50 & 100 phr respectively.

DESIGN IS FUNDAMENTAL IN A CIRCULAR ECONOMY

Footwear design can make a fundamental contribution to a circular economy by creating products that are desirable, functional and lightweight, avoid toxic substances, have a long service life, are easy to repair and have been designed with recycling in mind. Design for recycling includes products made from a minimum number of different materials; uppers made of the same base material (e.g. outer and inner parts all in leather or recyclable microfibres) separable from the sole (e.g. recyclable thermoplastic or rubber materials).

Recycling and maintaining materials in a perpetual cycle or fully closing the loop is, unfortunately, not possible because of the integral properties of different materials and the processing steps involved in producing or recycling them. A certain fraction of a material is released or dissipated throughout its life cycle into unrecoverable forms, so a recycling rate of 100% can never be reached.

Additionally, in footwear, some materials such as polymers can, due to their molecular properties, be sensitive to heat (e.g. during melting), UV radiation or impacts in use which leads to certain degree of degradation and limits the number of cycles that are possible, until a point is reached where a material can no longer be effectively recycled.

Biological materials as well as polymers are composed of carbon and therefore the best final step would be efficient energy recovery when further material or nutrient utilisation is no

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The FASCOM project aims to produce a more circular economy model for footwear.
CREDIT: CTC

and developments resulting in new technologies and business models. In this frame, CTC, shoe manufacturer SOZÉ, cutting, quality control and robotic systems manufacturer CEI – ZIPOR, retail business technology provider InovRetail and development institute INESC TEC, all located in Portugal, are jointly developing the FASHION COGNISANT Manufacturing (FASCOM) project.

FASCOM is a Portugal 2020 R&D collaborative project, aiming to give rapid, efficient and sustainable response to consumer fashion trends and preferences through analysis of interactions in both virtual and physical stores. It will also seek to develop new and more environmentally friendly materials, 'intelligent' manufacturing processes and appellative 'wanted' product concepts, all leading towards a more circular economy model.

To implement the model, several solutions are being developed and validated on an industrial scale. A smart phone application supports new products selection, specification and acquisition, an in-shop interactive exhibitor helps the consumer to choose a customised product in an intuitive and simple way. Both solutions give product information and suggest alternative articles. A new sales application advises retailers and shop managers of consumer requests, recommendations and possible causes of lost sales. A Cloud-based system integrates the various solutions and then communicates relevant information to the entire value chain.

Using these InovRetail tools, the consumer can specify their 'desired shoe' from a wide range of colours, upper drawings and detail combinations. By involving the consumer in the specification of desired fashion products, FASCOM can contribute to increased shoe usage and service life. Consumer's interactions will also result in trends towards supporting producers and retailers in the creation of products that are truly wanted by consumers and are therefore products that are better used.

Sustainable production of the new shoes is made possible by the development of new processes and materials that can be customised in terms of colours and drawings. These allow SOZÉ to produce a pair of each

longer possible. Landfills are also important for helping to maintain residual streams where no other treatment options are available.

PRODUCTION WASTE RECYCLING

Waste prevention, recycling and efficient management play important roles in optimising material and energy use within the circular economy model and represent a golden opportunity for the footwear and allied trade sectors, waste management sector and for cross-sector collaboration.

An example of potential cross-sector collaboration has been identified by CTC, the Portuguese footwear technical and innovation centre. In the study it carried out, industrial upper and sole roughing wastes, without any further preparation, were added to an acrylonitrile butadiene rubber (NBR) formulation in a range of 20 to 100 phr (parts per hundred rubber) and the subsequent relevant physical properties evaluated (Figure 2).

The results show that hardness rises gradually with the increasing addition

of upper leather and sole dusts from 62 up to 85 and 80 Shore(A) respectively. An increment in tear resistance is also observed until a level of 50 phr addition is reached. Although abrasion resistance decreases with increasing additive incorporation, the composites prepared nevertheless have abrasion resistance adequate for a high range of footwear applications.

An increase in tensile strength and elongation at break relative to the base NBR formulation is observed for the 20 phr composites. As far as flex resistance is concerned, composites up to 50 phr of additives incorporation gave around 0.01mm/kcycle, which can be considered satisfactory. Based on these results, residues from footwear roughing operations such as in the conditions studied here, might be recycled as day-to-day footwear rubber soles additive at up to 20 phr incorporation.

NEW TECHNOLOGIES, PRODUCTS AND BUSINESS MODELS

The circular economy may also promote new professions, innovations

colour/drawing combination in a flexible and efficient way. Only the area of upper material required by each pair is coloured and finished thus optimising the resources used in terms of materials and chemicals used and reducing waste material contaminated by colouring.

A new innovative CEI – ZIPOR intelligent vision system and high performance knife cutting machine automatically recognises and cuts the coloured upper sections. This ensures the effective integration of the customised product into the production process, reducing raw material consumption and waste to a minimum. New footwear concepts based on leather and man-made fibres combine the consumer's aesthetic decisions with functional requirements such as fitting, cushioning and circular economy attributes. *Figure 3* lists some characteristics and technical enabling factors of a possible footwear circular economy considered.

The Standfor patented shoes, developed and produced by SOZÉ, are made in recyclable microfibre, are aesthetically customisable and offer

Figure 3 – Characteristics and enabling factors of a circular economy.

CHARACTERISTICS

- **Less input and use of natural resources:** Efficient use of natural resources in added value products and minimised water use (colouring).
- **Recyclable resources:** Increased share of recyclable and recycled materials (replace virgin) and closure of materials loops.
- **Energy:** Option for supplies with increased share of renewables.
- **Reduce emissions and materials losses** through new cleaner materials and product cycles.
- **Keeping the value in the economy:** Quality, consumer desired, extended lifetime keeps the value of products in use.

ENABLING FACTORS

- **Eco-design:** Products designed for a longer life, enabling repair and substitution of hazardous substances in products and processes.
- **Recycling:** Avoidance of mixing and contaminating materials and use of recyclable materials.
- **Business Models:** Collaboration and transparency along the value chain and industrial symbiosis (waste of one company becomes a resource for another).
- **Eco-innovation:** Technological and organisational innovation.
- **Social:** Contribution to changing to a sustainable consumption by involving the consumer in the product customisation and longer use.

high durability and biomechanical comfort. The application of Eco-design criteria has resulted in products made from an optimised number of different materials and chemicals that are easy to maintain and are suitable for reuse and recycling.

The overall knowledge generated by the FASCOM concept can also

contribute to the production and selection by retailers of products that will be quickly sold. This in turn would reduce stocks, promotions, products with short life cycles, undesired items and waste products, thus decreasing materials and energy resources consumed as well as production and distribution waste. 🔗

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