Future of footwear recycling

The world's first footwear recycling system was developed by a team of researchers lead by Professor Shahin Rahimifard at the Centre for Sustainable Manufacturing and Recycling Technologies (SMART), at Loughborough University in the UK. It was covered in some considerable detail in the May/June issue of *World Footwear* last year. While the system has proved thoroughly practical in terms of technology, it needs to operate on a large scale basis in order to become commercially viable. The team's attention during the past twelve months has therefore been on identifying what would be required to do this and what actions to take.

As a brief reminder as to what is involved, this footwear recycling system is able to recover different material streams from footwear including leather, foam, rubber, plastics, and textiles by using various fragmentation and separation processes including granulation, air-based, density-based and size-based systems. It currently recovers materials that are considered to be 'down-cycled' and only suitable for low value applications such as insulation, construction and surfacing materials. Higher quality and purity of materials can be achieved through repetition of fragmentation and separation processes, but this increases throughput time and hence the overall cost of recycling.

Researchers at SMART are now looking at ways of increasing the quality of the recovered materials from post-consumer products, thus improving the commercial viability of footwear recycling. This work, in addition to improving the recycling technologies themselves, is also focusing on challenges in earlier stages of product life cycle such as actual design, material preparation and production, based on a proactive approach, to reduce the efforts required to recycle the footwear products at the end of their lives.

Footwear recycling line at the Centre for SMART.
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ELIMINATING THE USE OF METAL

Metal removal is the most complex stage of the footwear recycling process. The frequent heavy encapsulation of metal components within the footwear itself means that automatic detection mechanisms can often fail and, as a result, the undetected metal fragments not only cause damage to the recycling equipment itself but also severely limit the application options for the resulting recycled materials. Metal removal is currently carried out manually due to the difficulties associated with automated processes. This manual recycling is not only arduous and hazardous, but also incurs high labour costs thus making it unsuitable for the large-scale recycling of footwear needed to make it commercially viable.

The SMART research team is therefore actively promoting the total elimination of metal components in footwear production and investigating the potential of substitute materials, such as carbon-fibre composites, reinforced plastics and fibre reinforced plastics. Although the metal substitutes currently available present a number of challenges in terms of meeting the functional requirements necessary such as stiffness and rigidity, decorative and aesthetic appearances, these are not seen as being insurmountable.

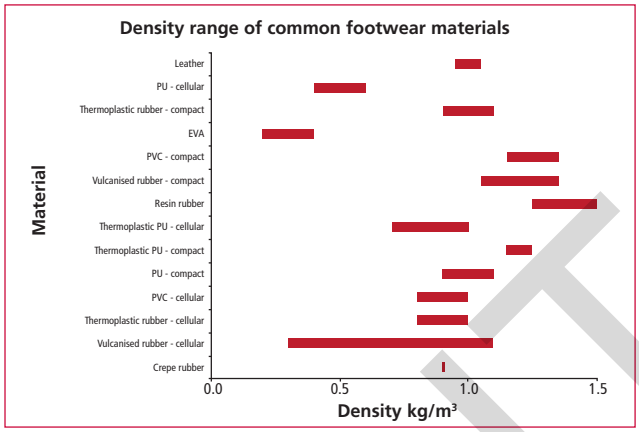
DESIGN FOR RECYCLING

The innovative 'Design for Recycling' tool produced by researchers at the Centre for SMART predicts the level of material separation that would occur during the end of life recycling process based on a pre-selected combination of material mix. This is achieved through modelling the interaction between various waste materials based on their specific characteristics (e.g. density and terminal velocity) and consideration for a range of potential applications for material reuse. Using this information, footwear designers are able to identify and choose the most suitable combination of materials that would reduce the recycling effort needed and improve the quality of recycled materials obtained.

MIXED PRODUCT RECYCLING

A substantial proportion of the cost of footwear recycling is incurred by the collection and sorting of used shoes. Within urban areas and large cities, the amount of footwear waste collected as a feedstock for a potential recycling system is great enough to justify the set-up and operational costs of a recycling facility. However, in other areas where the level of feedstock required to make the process economically viable does not exist, collecting and recycling other end-of-life products with a similar

End-of-Life footwear decision support tool.



Density range of common footwear materials.

materials content to footwear could be worth considering.

In this context, SMART researcher Tegan Pringle is investigating a novel solution referred to as RRS (Reconfigurable Recycling Systems) in which a range of used products with similar material content can be processed. These systems utilise a series of 'plug and play' interchangeable processes to provide flexibility to the recycling line and have the ability to switch off a process or re-direct waste flow automatically depending on the nature of the products being recycled.

This, for example, allows leather footwear to be recycled on the same line as leather apparel and other leather luxury goods such as handbags, briefcases, wallets, purses and travelling bags. Whereas these items may require a slightly different set of recycling processes in order to provide good material recovery yields, the significant increase in the scale of waste being processed would improve long-term economic sustainability.

SMART's view is that if we want to embed sustainability considerations across the value chain for the production and consumption of footwear, the way products, services and businesses are designed and delivered needs to be changed. This, in turn, will require such considerations to be systematically and purposefully incorporated within existing practice at every stage of a product's life cycle.

As part of an on-going global programme referred to as 'Global Leather Recovery', the researchers at Loughborough are engaging with various stakeholders within the footwear value chain in order to develop an overall consensus for future R&D initiatives that could help to make footwear recycling an accepted and commercially viable practice. Those involved so far include footwear manufacturers and retailers, chemical producers and tanners, as well as designers and consumers. Indeed, SMART would welcome additional input from anyone else who might be interested.

Professor Rahimifard is keen to stress that such long-term aspirations and strategies for improving the recyclability of footwear products require global acceptance and implementation if they are to succeed.

Typical metallic items found in footwear. Steel shanks moulded into soles are particularly difficult to extract.