

Recycling of Footwear Products

A Position Paper Prepared by

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Executive Summary

- i. On the 24th October 2007 Loughborough University organised and facilitated a workshop on the “Recycling of Footwear Products”. The event brought together key stakeholders from the footwear sector including shoe manufactures, retailers, designers, recyclers, trade associations and Governmental organisations.
- ii. The aim was to discuss the current state of shoe recycling within the UK and engage stakeholders as to the feasibility of various technologies and processes to deal with the current footwear waste problem. The event was also intended to provide a forum to discuss the future direction of shoe recycling, and the barriers that must be overcome to achieve a coherent UK footwear recycling strategy.
- iii. Dr. Shahin Rahimifard, Director of the Centre for Sustainable Manufacturing and Reuse/Recycling Technologies at Loughborough, opened the meeting by providing workshop participants with an overview of the scale of the post-consumer shoe waste, before highlighting the pro’s and con’s of processing technologies and waste management options that are currently available within the UK. These included; footwear reuse, material recycling and energy recovery based on incineration or gasification.
- iv. The workshop participants were asked to offer their opinion as to the viability and sustainability of each of the processing options available, and to identify the best solutions to deal with the current footwear waste produced. This was then extended to discuss the economic and infrastructure requirements for the establishment of a national footwear recycling scheme within the UK.
- v. The final part of the workshop discussed the long-term recycling solutions and technology gaps identified by the participants. This assisted in identifying areas that required further investigation. The event was concluded with a proposal to establish a Footwear Recycling Working Group to further the understanding and collaboration initiated within the workshop.

1) Introduction

This position paper provides an overview of the scale of post-consumer footwear waste, legislative requirements, existing recycling solutions and the key factors influencing the establishment of a nationwide footwear recycling scheme in the UK. The paper has been prepared to facilitate industrial awareness and to communicate the key issues with the wider community of stakeholders in the footwear sector.

A workshop on “Recycling of Footwear Products” was held at Loughborough University on the 24th October 2007, which brought together an array of stakeholders from the footwear sector including; shoe manufacturers, retailers, designers, recyclers, trade associations and Governmental organisations. The aim of the workshop was to discuss and identify potential solutions for recycling of footwear products and encompassed four key areas of discussion:

- Current solutions for recycling of footwear products
- Economic implications of collecting and recycling of post-consumer shoes
- Long-term solutions and technology gaps
- Immediate actions required to set up a nationwide footwear recycling scheme

The workshop agenda together with the list of participants can be found in Appendix I and II.

2) An Overview of End-of-Life Waste in the Footwear Sector

The footwear industry is a manufacturing sector which utilises a wide variety of materials and processes to produce a range of distinctly different products, from sandals to specialised safety footwear. Shoes are designed to fulfil an array of consumer requirements relating to function and fashion, and incorporate varied range of designs and styles. In addition, a range of distinctly different materials such as leather, synthetic materials, rubber and textile are commonly used in shoe manufacturing. These materials differ not only in their appearance but also in their physical qualities, their service life, the different treatment needs as well as their recycling and recovery options at the end of their useful life. There are approximately 40 different materials used in the manufacturing of a shoe¹. For example, Figure 1 represents the average composition of a typical men’s shoe which has been measured after grinding. These variations in designs, styles and materials, together with the environmental and economic implications of end-of-life shoe processing determine the feasible approaches to deal with this rapidly increasing waste stream.

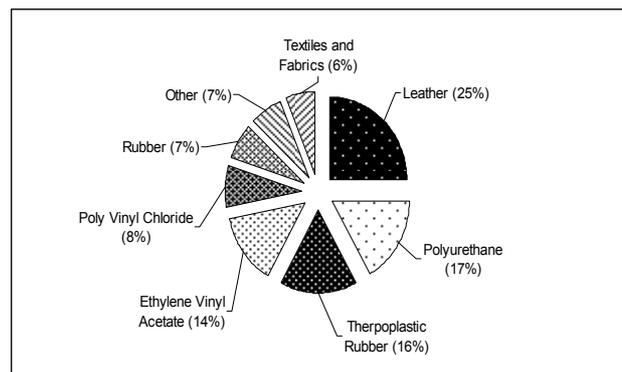


Figure 1: Material Composition in Average Shoe (%wt)

Over the last 20 years, the footwear sector has placed significant effort in improving material efficiency, as well as eliminating the use of hazardous materials during the production phase. However, the environmental gains made in production are being overtaken by the negative impact of the considerable increase in the demand for footwear products.

¹ Weib M., Recycling alter Schuhe, Schuh-Technik, 1999, May-June, pp. 26-29.

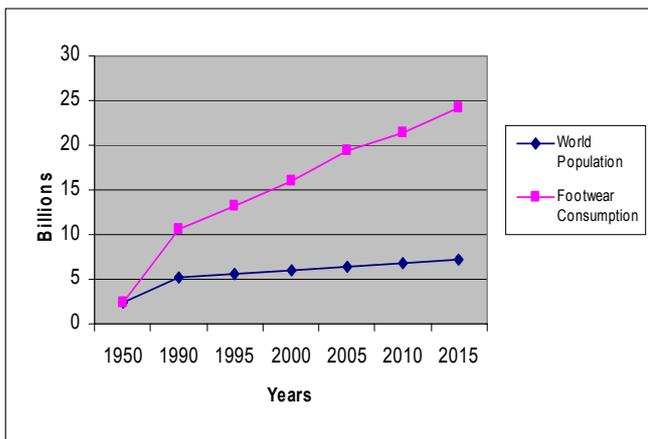


Figure 2: Global Footwear Consumption

Worldwide footwear consumption has doubled every 20 years, from 2.5 billion pairs in 1950 to more than 20 billion pairs of shoes in 2005² (see Figure 2). As a result, the worldwide per capita consumption of footwear has also considerably increased, from 1 pair of shoes per year for every person in the world in 1950 to almost 2.6 pairs of shoes in 2005. In the European Union, footwear consumption has increased by 22% from 2002-2005 to reach 2.3 billion pairs of shoes³. However, the per capita figures differs significantly between each country⁴ (see Table 1). Although China has the highest footwear consumption in

the world, the United States is the country with the highest per capita shoe consumption, since each inhabitant purchase an average of 6.9 pairs of shoes every year. At the other extreme, in the less developed countries, the per capita figure is 0.6 pairs for India and 0.5 pairs of shoes for Vietnam (which means one pair of shoes for each person every two years). This rapid growth in shoe sales has also resulted in a significant increase in post-consumer footwear waste. In the EU, it is estimated that the waste arising from post-consumer shoes will reach 1.2 million tonnes per year. The retail figure for 2003 indicated that around 338 million pairs of shoes were sold in the UK. Based on this figure, it is estimated that the waste arising from post-consumer shoes reached 169,000 tonnes. In addition, it has been estimated that the total arising of textile and footwear waste is approximately 1,165,000 tonnes per year in the UK, while the amount of textile waste reused or recycled annually is estimated to be 324,000 tonnes⁵.

Based on a Department of Trade and Industry (DTI) study, about 9% of all recovered post-consumer textiles are sold as second-hand shoes⁶. This indicates that around 29,160 tonnes of post-consumer shoes are collected each year for direct reuse in the UK or for exportation to developing countries. However, it is estimated that approximately 10% of the collected second-hand shoes are not suitable for reuse due to their condition, and consequently end up in landfill. Therefore, based on these estimates, approximately 15% (26,244 tonnes) of post-consumer shoe waste in the UK are collected and re-distributed as second hand shoes, while the rest (85% or 142,756 tonnes) are disposed of in landfills.

Countries	Population (million inhabitants)	Footwear Consumption (1,000 pairs)	Footwear Consumption /Capita/Year
EU-25	463.5	2,355,667	5.0
Germany	82.5	320,800	3.9
France	59.6	335,500	5.6
UK	59.3	312,800	5.3
Italy	57.3	395,300	6.8
Spain	41.5	136,200	3.3
Netherlands	16.1	74,100	4.6
USA	289	2,007,899	6.9
China	1,287.1	2,900,000	2.2
Brazil	186.0	490,000	2.6
India	1,041.9	N/A	0.6
Vietnam	84.2	N/A	0.5

Table 1: Breakdown of Global Footwear Consumption

² World Footwear (2007). Future Applications of Polyurethanes, World Footwear, January/February 2007, Cambridge, Mass: Shoe Trades, pp.32-35.

³ European Commission (2005). European Union Footwear Statistics. <http://europa.eu.int/comm/enterprise/footwear/statistics.htm>

⁴ SATRA (2003). Footwear Market Predictions: Forecasts for Global Footwear Trading to 2009, (SATRA Technology Centre: Kettering), CBI (2004). EU Market Survey 2004: Footwear. Available online at: <http://www.cbi.nl/marketinfo/cbi/?action=showDetails&id=223&via=pub>

⁵ Oakdene Hollins (2006). Recycling of Low Grade Clothing Waste. Available online at: www.oakdenehollins.co.uk/pdf/Recycle-Low-Grade-Clothing.pdf.

⁶ ERM (2006). Textile Recycling, Fact sheet researched and written for the Department of Trade and Industry (DTI). Available online at: <http://www.wasteonline.org.uk/resources/InformationSheets/Textiles.htm>.

Though in the UK at present the total weight of post-consumer shoe waste sent to landfill by local authorities is not monitored, based on the annual retail footwear figures the cost of managing this waste stream is predicted to substantially increase due to the escalation of the landfill tax.

3) Landfill Restrictions and Producer Responsibility Issues

It is commonly reported that the dumping of waste in landfill can result in serious environmental pollution of groundwater and rivers, as well as harmful emissions of greenhouse gases (e.g. methane). Furthermore, landfill space is becoming extremely limited, while the number of landfill sites in the EU has considerably decreased over the recent years. Current estimates by the Environment Agency highlight this severe shortage of landfill capacity within the UK, reporting a figure of 3-4 years of remaining space in London and East Anglia, and between 5-9 years elsewhere⁷.

In addition, the EU Landfill Directive promotes the diversion of waste from landfills towards products and materials recycling using a variety of measures⁸. The landfill restrictions introduced by the Article 5 of this Directive determines the amount of biodegradable waste that can go to landfill and the prohibition of landfilling for certain waste types. The UK Landfill Allowances and Trading Scheme Regulations (LATS) introduced in 2004, determines the percentage of certain waste type that are regarded as biodegradable municipal waste⁹. These biodegradable percentages range from paper, cardboard and vegetable oils (potentially 100% biodegradable) through to footwear, furniture and textiles (50% biodegradable), and to batteries, glass and metal waste (0% biodegradable). This means that certain types of biodegradable materials such as leather, natural textiles, natural rubbers etc., which are extensively used by the footwear industry, will be soon required to be reused or recycled instead of directly disposed of in landfill sites.

Additionally, the emergence of the concept of producer responsibility has extended the liability of manufacturers, distributors and retailers beyond the 'use' phase of products into the post-consumer phase. Producer responsibility is also concerned about closing the loop with respect to materials use and waste management at the end-of-life phase, while providing a source of financing for recycling, energy recovery and disposal. In this context, producer responsibility legislation is expected to affect the footwear sector in future, similarly to what has happen in other consumer product sectors, e.g. packaging, automotive, electrical and electronics.

4) Current Reuse and Recycling Solutions for Footwear Products

The response of the footwear industry to the increasing problems associated with shoe waste has been negligible. In particular, considering that more than 60% of the UK shoe sales are leather-based shoes¹⁰, the recycling of finished leather from post-consumer shoes has not been commercially exploited. The current recycling solutions available for various types of waste in the footwear sector are depicted in Figure 3 and are briefly described in the following sections.

⁷ Environmental Agency (2005). Waste Data Update, <http://publications.environment-agency.gov.uk/pdf/GEHO0707BMZE-e-e.pdf>

⁸ Directive 99/31/EC 1999

⁹ Landfill Allowances and Trading Scheme (LATS) Regulations (2004). Statutory Instrument 2004 No 3212, Department of Environment, Food and Rural Affairs.

¹⁰ CBI (2004). EU Market Survey 2004: Footwear. Available at: <http://www.cbi.nl/marketinfo/cbi/?action=showDetails&id=223&via=pub>

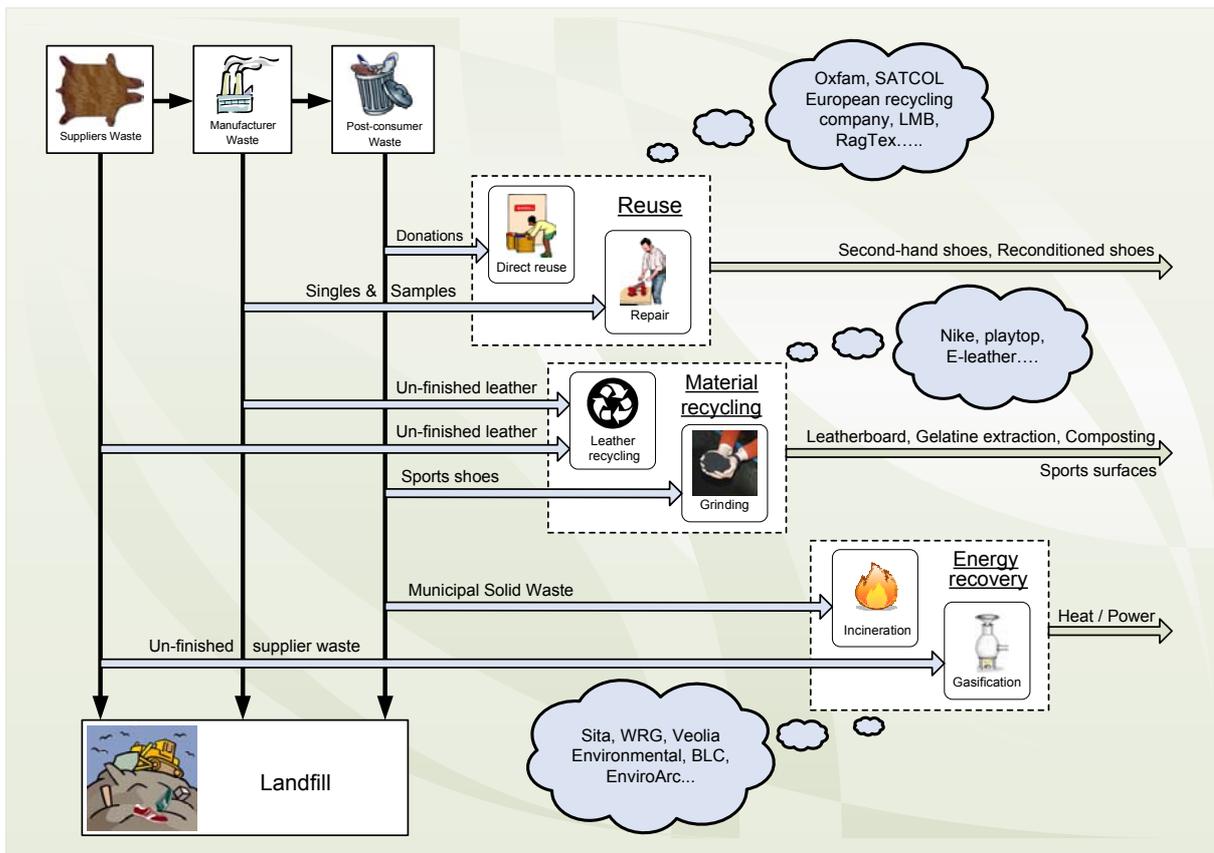


Figure 3: Current Recycling Solutions

4.1 Reuse

Pros:

- Extending the 'use' life of shoes
- Established collection method via recycling banks and charity shops
- Creation of jobs in less developed countries

Cons:

- Transportation (carbon miles)
- Overall environmental impacts (diverting waste from the developed world to less-developed countries)
- Economic impacts (restricting the development of local footwear industry)

Direct reuse of second-hand shoes is a well-established method of collecting worn or unwanted shoes for either local redistribution or exportation to less-developed countries. Such reuse schemes are mainly supported by charitable organisations such as the Salvation Army Trading Company Ltd. (SATCOL) and Oxfam, or private companies such as European Recycling Company, Lawrence M Barry & Co and RagTex. In the UK, Oxfam alone with its shop donations and door-to-door collections recovers around 5-10 tonnes of worn or unwanted shoes every week.

There are a number of conflicting views regarding the environmental impacts and the economic consequences of such reuse activities within the developing countries. A recent study by Oxfam¹¹ indicates that the second hand trade of clothing has clear consumer

¹¹ Oxfam (2005), The Impact of Second-Hand Clothing Trade on Developing Countries. Available online at: http://www.oxfam.org.uk/what_we_do/issues/trade/downloads/research_shc.pdf

benefits and “supports the livelihoods of hundreds of thousands of people in developing countries who work in trading, distribution, repairing, restyling, washing, etc. of the imported products”. However, the same study also suggests that second hand goods are “likely to have played a role in undermining industrial textile/clothing production and employment in West Africa, which has experienced a serious decline in the 1980’s and 1990’s”. Furthermore, it has been argued that the collection and exportation of worn or unwanted shoes from developed countries diverts waste into less-developed nations that have little or no infrastructure to deal with the additional waste. This clearly highlights the needs for further investigation into the environmental, economical and social impacts of exportation of second hand footwear products as a long term sustainable strategy.

Another form of reuse activity is the repair and refurbishment of high quality shoes where the used shoes are returned to local cobblers, and in some cases to the original equipment manufacturer to be reprocessed, thereby prolonging their useful life. There are approximately 1500 ‘shoe repairers’ listed in the UK business directory, but many promote other services such as key cutting and engraving above their shoe refurbishment services¹². In the case of hand-made expensive shoes, such as those produced by Church & Co, repair and refurbishing is an important facet of the overall business. As many as 18,000 pairs of shoes are returned to this company every year, which may be up to 40 years old. After refurbishment, shoes are boxed as new and returned to the customer¹³.

4.2 Material Recycling

Pros:	Cons:
<ul style="list-style-type: none"> • Proven technology for the recycling of athletic shoes (more than 20 million pairs of post-consumer athletic shoes have been recycled) • Established market for shoe recycled materials (surfacing) 	<ul style="list-style-type: none"> • Limited application to athletic shoes only (with no metallic parts) • Recycling of post-consumer finished leather is not currently available

Nike’s recycling programme “Reuse-A-Shoe” is the only well known product take-back and recycling scheme of post-consumer shoes currently established by a shoe manufacturer. This programme has been operating for over a decade in the United States and also just recently started operating in the UK, Australia and Japan. Nike’s scheme involves a series of collection points in retail centres, sports stadia and university campuses where consumers can deposit their worn-out and discarded athletic shoes. The shoes are then collected and taken to a central recycling facility where they are shredded to produce a material known as “Nike Grind”, which is used for surfacing tennis and basketball courts, playgrounds and running tracks. According to Nike, since its inception in 1993, “Reuse-A-Shoe” programme has recycled in total more than 20 million pairs of worn-out and defective athletic shoes.

4.3 Energy Recovery

Post-consumer shoe waste can also be used in order to generate heat and electricity. Energy recovery from waste includes a number of established (e.g. incineration) and emerging technologies (e.g. gasification and pyrolysis), as outlined below.

¹² Personal communication with UK shoe repairer forum, 26th Oct 2007.
<http://www.shoerepairer.info/bb/viewtopic.php?t=2337>

¹³ Leather International (2007). CHURCH: the inside story. Leather International. Available online at:
<http://www.leathermag.com/story.asp?storyCode=45840>

4.3.1 Incineration

Pros:

- Established method (municipal incineration plants, co-combustion in rotary/cement kilns etc.)
- High calorific value of leather

Cons:

- Harmful air emissions
- Low public acceptance in the UK

Currently 2.8 million tonnes (9%) of municipal waste and 100,000 tonnes (3%) of hazardous waste is treated in incineration facilities in the UK. In 2002, this generated enough power for over ¼ million homes through 'Combined Heat and Power' schemes. However, waste incineration is a subject of intense debate due to the range of harmful air emissions released from such activities, and in recent years the negative public perception has successfully challenged the planning permission required to build new incineration facilities in the UK.

4.3.2 Gasification

Pros:

- Applicable to a variety of waste types
- No harmful air emission released

Cons:

- Expensive technology (approximately £165/tonne)
- Not proven for post-consumer shoe waste

Gasification converts any carbon-containing material into a combustible gas (comprising of carbon monoxide, hydrogen and methane) which can be used as a fuel to generate electricity and heat. In the case of leather waste, gasification technology has been tested in a 50kg/h leather waste gasification unit which was installed in a leather tannery plant in Leeds-UK with some reported success in early experimentations¹⁴. The only other commercial gasification plant that treats leather and tannery waste has been built in Borge Garveri-Norway, as an extension of activities at one of Scandinavia's top tanneries. The process is based on a shaft gasifier (Pyroarc) manufactured by EnviroArc, and the resulting products in addition to a combustible syngas are an iron-chromium alloy and a melted slag for recycling. At the moment, however, such gasification units accept only raw material waste directly from tanneries and not post-consumer leather products such as shoes.

5) Establishing Nationwide Footwear Recycling in the UK

Short-term recovery solutions based on readily available technologies and processes are required to deal with the waste generated as a result of 338 million pairs of shoes sold within the UK each year. The availability of fashionable and affordable shoes has led to a fundamental change in attitudes towards shoe purchasing, with shoe retailers enjoying a sustained period of growth in recent years (a 34% increase in consumer spending between 2001-2005¹⁵).

The following subsections present the workshop group discussion relating to the current post-consumer shoe recycling activities available within the UK, and the need to identify the best short-term solutions to deal with the waste currently produced.

¹⁴ ENDS (2003). Pittards: Putting a green finish to the leather industry. ENDS Report. 340, May.

¹⁵ Mintel (2005) Footwear (UK) - Market Size and Trends, August 2005.

5.1 Current solutions for recycling of footwear products

The participants were asked as to their knowledge of other existing shoe recycling activities besides those summarised in Section 4 of this paper, but were not aware of any additional solutions. This was followed by consideration of the various types of footwear waste produced within the industry which were summarised as; post-consumer, over-production, samples, returns, defects and odd size pairings.

It was highlighted that currently shoe reuse is the most widely adopted recovery approach within the UK, with well established infrastructures to support reverse logistics. The **Textile Recycling Association** indicated the exact figures regarding the scale of shoe exportation from the UK were unclear, because whilst there is a specific export code for used clothing there is not one for used shoes/footwear. The estimated figure of 26,244 tonnes (see Section 2) was considered by the group to be an optimistic estimate for the scale of current collection and reuse activities within the UK. Furthermore, concerns were voiced as to the long-term sustainability of exporting second-hand shoes for reuse as an end-of-life processing option due to previously mentioned environmental and economical impacts in developing countries.

Shoe recycling technologies have had limited success within the UK. The majority of established leather recycling businesses are focused at the waste produced within the shoe manufacturing process. **E-Leather** stated that recycling of leather is currently restricted to un-finished manufacturing waste, citing the increased frictional effects of finished leather as the main barrier for the processing of post-consumer shoes. The only other post-consumer example of shoe recycling is through the Nike's 'Reuse-A-Shoe' program, which utilises granulated rubber recovered from athletic shoes to produce sports surfaces and running tracks. **Nike** noted that the extension of this crumbing approach to other leather-based shoes is currently questionable due to the lack of established markets for such recycled materials. **Playtop** also highlighted that the use of current Nike Grind material is limited to 35% of their sport surfaces as the size of the granulate make it impossible for the material to be used in many of their products. In addition, **Playtop** stated that the typical life of these sports surfaces are around 20 years, and the company is currently investigating the recycling potential of their surfacing material after this period.

Incineration is currently adopted in some local authorities to process municipal solid waste, and therefore it can be assumed that certain quantities of post-consumer shoe waste is indirectly processed via this method. However, the viability of the adoption of this technique to deal with the large quantities of footwear waste was questioned by the participants. Although, the high calorific value of leather waste (18.3 MJ/Kg)¹⁶ makes it suitable for use within energy recovery technology, questions regarding the safety of emissions produced during the shoe combustion process (e.g. the quantities of Chromium 6 and Polyvinyl chloride) would need further investigation. **Pentland** suggested strong evidence would be required as to the environmental benefits of this approach before such an end-of-life strategy were publicly endorsed.

5.2 Economic implications of post-consumer shoe collection and recycling

The establishment of a collection infrastructure and recycling facilities to process the quantities of footwear waste currently produced within the UK will have serious economic ramifications. Two models for funding mechanisms were discussed by the group and are summarised below:

¹⁶ Gutierrez, M. et al (2005), "Nitrous oxide (N₂O) emissions from waste and biomass to energy plants", *Waste Management & Research*, 23 (2), pp. 133-147

- i. **Environmental levies at point of sale:** This would be added directly to the recommended retail price (RRP) and would be similar to the textile 'eco-tax' introduced in France earlier this year, which charges 0.05 €/kg on new leather and shoes products to cover the costs of reuse and recycling. **George Clothing** raised the question as to the amount of this levy and its potential impact to the cost of certain shoe types that already had tight margins of profit (e.g. cheap mass produced consumer footwear). An alternative approach was highlighted by **E-Leather** and **Soletech Systems** to incentivise shoe returns via a tax rebate in the form of cash or clubcard credit.
- ii. **Take-back levies from manufacturers:** This would be a system similar to that adopted within the packaging and electronics recycling sector, whereby quantities of 'shoe recovery notes' would be purchased by manufacturers from recyclers based on their market share. The funds collected through shoe recovery notes would then be used to pay for the take-back and recycling of shoes.

Regarding the possible methods to establishing the reverse logistics for increased shoe recycling, the group identified three possible scenarios:

- a. An increased quantity of recycler collection banks at retail parks and recycling points.
- b. Return facilities at all shoe retailing outlets.
- c. Local authority collection via the use of shoe recycling bags.

British Footwear Association argued that a significant expansion of existing recovery capacity might not necessarily result in an increase in the amount of shoes collected. Instead consumer awareness and apathy were cited as the main barriers for the extension of existing shoe collection activities. Hence, concerns were raised regarding the effectiveness of the first two approaches based on current post-consumer recycling trends. **Nike** highlighted the need for the shoe returning exercise to be made more convenient, expressing a view that consumers may be reluctant to carry their old shoes while shopping. **European Recycling Company** suggested that if consumers were made aware of the positions of shoe recycling banks, this approach may still provide the most convenient collection method. The requirement for substantial investment in infrastructure, public awareness and recycling technologies was strongly voiced by all. **Environment Agency** stated that questions regarding the financial viability of some of the more fringe recycling technologies will become clearer in the coming years as the technology becomes; cheaper, more established and financially comparable with the cost of landfilling.

5.3 Long-term solutions and technology gaps

There was a united consensus on the need for additional investigation as to the environmental and economic ramifications of the current and future footwear recycling activities within the UK. **Textile Recycling Association**, **Pentland** and **Terra Plana** suggested that any further investigation should begin with a carbon-footprint analysis of the current footwear recycling options (i.e. reconditioning, reuse, recycling and energy recovery), accompanied by the analysis of £/tonne end-of-life processing cost to provide a suitable comparison with escalating landfill prices. Furthermore, due to the multi-material composition of current footwear, **British Footwear Association** and **George Clothing** stressed the need to diversify this analysis to include all footwear types and not only leather-based shoes. **Pentland** and **Next** pointed out the advantages of gasification over incineration, in particular in cases where re-use or recycling are not viable options and highlighted the need for further investigation in gasification technology. Additional areas of research identified by the group included:

- i. The need to understand the environmental impacts of the shoe manufacturing processes as well as its end-of-life recovery.
- ii. The exploration of a 'design for recycling' approach for footwear products to improve the economic viability of post-consumer recovery.
- iii. The creation of automated disassembly technologies to assist in the segregation of different material types to generate useful and marketable end-of-life materials.
- iv. The investigation of a number of business models within the footwear recycling sector to suggest the best ways to exploit a nationwide shoe recycling scheme within the UK.

5.4 Immediate actions required to set up footwear recycling scheme

To raise the profile of post-consumer shoe recycling and to deal with the abundance of footwear waste currently produced within the UK, the discussion moved towards the steps required to establish a nationwide footwear recycling scheme. The intended aim was to determine a group consensus as to the short-term actions required to implement shoe recycling, using current technology and markets.

The group stressed the role that Government and local authorities needed to play in this activity and the use of the national waste management infrastructure currently in place (i.e. curb-side collection). Barriers highlighted by the group regarding the engagement of these two stakeholders within a national footwear recycling scheme were identified as the lack of detailed understanding of the environmental benefits of footwear recycling, and the varying waste management priorities of local authorities across the country. It was suggested that a detailed carbon-footprint analysis of current end-of-life footwear options could provide the catalyst for more comprehensive Governmental support, but doubts were raised as to the cooperation of local authorities due to the large number of other recycling campaigns currently vying for their attention and support (i.e. batteries, clothing, glass, etc.).

Tesco and **Next** cited the similarities between the implementation issues discussed within the workshop and those mentioned for post-consumer textile recycling. A specific reference was made to the "sustainable clothing roadmap" initiative led by the Department for Environment, Food and Rural Affairs (Defra) to provide strategic direction for sustainable consumption and production within the clothing sector¹⁷. It was suggested that this initiative would provide a suitable forum for further discussion of footwear recycling issues. Consequently, a meeting with Dr Dorothy Maxwell, the clothing roadmap lead within the Sustainable Consumption and Production (SCP) programme was held on the 3rd December 2007 in London. The purpose of the meeting was to compare the aims of the sustainability clothing roadmap with those of the remit of the workshop on footwear recycling. It became apparent from this meeting that the scope of the 'sustainable clothing roadmap' is extremely comprehensive, focusing not only on the environmental impacts of clothing but also on the social and ethical issues relating to their production. The 'sustainable clothing roadmap' is intended to take a whole life-cycle view of textile consumption, and considers the impacts of upstream supply and production right the way through to in-use maintenance and end-of-life disposal. A brief summary of discussions in this meeting is included in Appendix IV. The main results from the meeting was that Defra is very keen to facilitate the sharing of information and knowledge among the stakeholders in the clothing and footwear sectors, but is unable to extend the scope of the 'sustainable clothing roadmap' program to include the considerations of footwear products at this present time.

¹⁷ DEFRA (2007). Sustainability clothing roadmap: meeting briefing note. 5th Sept, 2007.
<http://www.defra.gov.uk/environment/consumerprod/products/clothing.htm>

6) Footwear Recycling Working Group

The discussion during the workshop highlighted the significant interest and necessity for the establishment of a nationwide footwear recycling scheme in the UK. It was also pointed out that effective growth of regional and small initiatives need national coordination and a coherent strategy to achieve the desired growth in the level of footwear products recycled in the UK.

To develop a national strategy for footwear recycling it was proposed to establish a Footwear Recycling Working Group. This group should have member representation from key stakeholders including; manufacturers, retailers, recyclers, trade associations, R&D organisations and an appropriate governmental representative.

It is predicted that this group will take the lead in:

i. *Seeking governmental grants to facilitate a nationwide footwear recycling scheme:*

The grants will be used to a) instigate feasibility projects including a comprehensive cost and carbon-footprint analysis to support the definition of a national strategy, b) to invest in improvement and expansion of collection and recycling infrastructure, c) to investigate new technologies required to reduce the environmental and economical impact of footwear recycling.

ii. *Engaging regional and national authorities:*

This is to promote the requirements for shoe recycling and to seek their active participation in implementation of a national strategy for footwear recycling. It is foreseen that the implementation of a nationwide footwear recycling scheme relies heavily on coherent regional support through a range of pilot projects which can effectively demonstrate the applicability and the benefits of the proposed strategy.

iii. *Providing expert support for development and implementation of appropriate national guidelines for footwear recycling:*

The active involvement by various stakeholders including manufacturers, retailers and recyclers is essential in developing practical and simple guidelines for footwear recycling. The footwear recycling working group is seen as an ideal forum to provide the collective knowledge required for the definition of such national guidelines.

iv. *Promoting public dissemination and awareness:*

This should be based on a wide range of mediums to publicise recycling activities and to inform consumers of manufacturer and retailer involvement in current and future footwear recycling initiatives.

7) Concluding Remarks

The participation on behalf of a wide range of key stakeholders from the footwear sector in the workshop at Loughborough emphasises the broad industrial support for the recycling of post-consumer footwear products. Clearly, there is a need to communicate the issues discussed in the workshop with other stakeholders to allow opportunity for other organisations to express their positions and interests. This position paper is generated as a vehicle to achieve this wider dissemination.

The workshop and the subsequent feedback from the participants have highlighted a number of key actions in the two specific areas of a) implementation of a nationwide footwear recycling scheme, and b) further investigation into footwear recycling, as summarised in Table 2. The achievement of the objectives within these two areas of work will be highly dependent on the willingness of stakeholders to take collective ownership of the footwear recycling initiative and to identify appropriate funding to ensure the realisation of this work.

	Actions
Implementation of nationwide footwear recycling scheme (short-term)	<ul style="list-style-type: none"> i. establish a Footwear Recycling Working Group ii. define the remit of members of the Footwear Recycling Working Group based on those that wish to have active participation and those that wish to have a watching brief iii. development of a work-plan for the Footwear Recycling Working Group
Further investigation into footwear recycling (long-term)	<ul style="list-style-type: none"> i. carbon footprint of various end-of-life treatment options for shoes ii. socio-ethical considerations of various end-of-life options iii. applicability of gasification technology for footwear waste iv. shoe design improvements to facilitate recycling v. semi-automated disassembly, fragmentation, separation and material recycling technologies for footwear products vi. cost-benefit analysis for potential markets for recycle footwear materials

Table 2: Key actions for post-consumer footwear recycling

Appendix I: Agenda of the Footwear Recycling Workshop



Workshop on “Recycling of Footwear Products”

Date : Wednesday 24th October 2007

Venue : Loughborough University
Wolfson School
Room TW1.12

Objectives

Currently, more than 20 billion pairs of shoes are consumed worldwide every year, and this figure continues to rise. In the European Union, footwear consumption has increased by 22% from 2002 to 2005 to reach 2.3 billion pairs of shoes, from which around 330 million pairs are sold every year in the UK. This creates an enormous amount of post-consumer (end-of-life) shoe waste, majority of which is currently being disposed in landfill sites. This workshop aims to bring together all the key stakeholders in the UK’s footwear sector in order to discuss and identify potential solutions for recycling of footwear products and to develop a position paper on the current state of shoe recycling in the UK.

Workshop Focus Areas

- Current solutions for recycling of footwear products
- Economic implications of collecting and recycling of post-consumer shoes
- Immediate actions required to set up nationwide shoe recycling schemes
- long-term solutions and technology gaps

Agenda

- 09:30. Arrival, Coffee
- 10:00. Welcome and Introduction
- 10:05. Definition of, Capabilities, Interests and Requirements
 - presentation (max of 2-3 mins) by each delegate
- 10:40 Overview of Current Shoe Recycling Activities
- 10:50. Open Discussion on Workshop Focus Areas
- 11:15. Refreshment Break
- 11:30. Open Discussion on Workshop Focus Areas (continue)
- 12:30. Summary and Plan of Actions
- 13:00. Networking and Lunch

The Organiser

The workshop is organised and hosted by the Centre for Sustainable Manufacturing and Reuse/Recycling Technology (SMART) at Loughborough University. Further information about the centre can be found at: www.lboro.ac.uk/smart

Appendix II: List of Participants

1) Environment Agency	:	Keith Bates
2) Pentland Group	:	Lesley Roberts
	:	Alison Tracy
3) Nike	:	Amber Price
4) TESCO	:	Abi Rushton
5) Next:	:	Joanne Poynor
6) Playtop	:	Marc Blamire
7) Terra Plana/Worn Again:	:	Galahad Clark
8) British Footwear Association	:	Niall Campbell
9) E-Leather	:	Andrew Hudson
10) Soletec Systems	:	Richard Allen
11) SATRA	:	A. Rockingham
12) European Recycling Company	:	Asrar Haqqi
	:	K. Cooper
13) George Clothing	:	Aysha Warrak
14) Textile Recycling Association	:	Alan Wheeler
15) Centre for SMART	:	Shahin Rahimifard
	:	Theo Staikos
	:	Gareth Coates

Appendix III: Shoe Recycling Activities at the Centre for SMART

The Centre for Sustainable Manufacturing and Reuse/Recycling Technologies (SMART) at Loughborough University has been involved for the last three years in a European Framework 6 - Integrated Project entitled, "Comfort, Environment and Custom - Made Shoes" (CEC-Made-shoes). The overall aim of the project was to develop radical new manufacturing processes, materials, products and services in order to increase the competitiveness of the European SME footwear sector. The Centre for SMART specific objective in this project was to develop systematic and economical procedures for recycling of footwear products. The results from these research activities can be summarised as follows:

- i. A comprehensive review of all existing recycling activities within the footwear sector.
- ii. A database of materials, construction and recycling processes.
- iii. A framework consisting of various recycling options for post-consumer footwear products.
- iv. A multi-criteria analysis of various end-of-life treatment options for post-consumer shoes including Life Cycle Assessment (LCA) for environmental impacts, Cost Benefit Analysis (CBA) for economic implications and Analytic Hierarchy Process (AHP) for socio-technical requirements.
- v. Industrial validation of the research activities through a number of case studies based on different footwear products (see Figures 3 and 4).

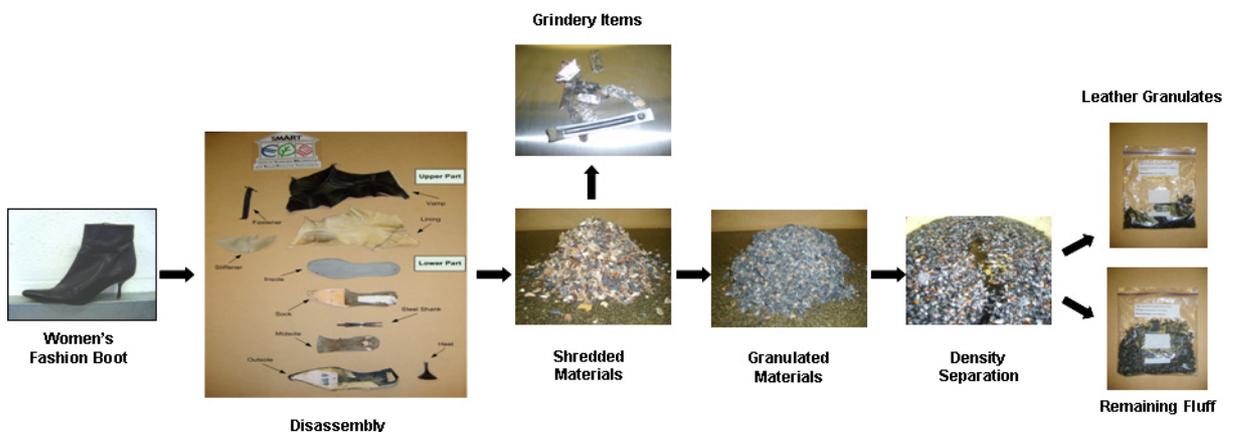


Figure 4: Case study based on a women's fashion boot



Figure 5: Case studies based on different post-consumer shoes

The results from this research work has highlighted the need for further investigation of novel approaches to design and recycling processes to facilitate the realisation of a sustainable product recycling chain for the footwear sector. The specific areas of further research identified in this study can be summarised as follows:

Shoe Design Improvements to Facilitate Recycling:

The consideration of shoe composition clearly indicates that a pair of shoes typically contains various materials such as leather, polymers, rubber, natural and synthetic textiles as well as metallic materials such as steel shanks and toe puff stiffener to provide better foot support and protection. In addition a range of different assembling techniques and processes such as stitching, cementing and injection moulding are used by the footwear industry to assemble the different shoe components into finished products. Therefore, a 'design for recycling' methodology for the footwear sector needs to be investigated to facilitate the ease of disassembly and separation and to reduce the overall cost of shoe recycling. The overall objective of such design approach will be to maximise the value recovery from post-consumer shoes whilst maintaining the original functional and aesthetic requirements.

Semi-Automated Shoe Recycling Systems:

Previous research at Loughborough has shown that recovery of post-consumer footwear products is largely an untapped commodity with strong recycling potential. This highlights the economic and environmental benefit that can be obtained from establishing a sustainable shoe recycling chain. However, current material recycling facilities and operators are either incapable of dealing with the specific material mix in the footwear products or do not provide the best method of recovering maximum value from post-consumer shoes waste. One of the major requirements for establishing sustainable recycling practices within footwear sector is to investigate novel disassembly and separation processes to successfully separate post-consumer shoes into well defined mono-fraction material streams which can have significant impact on the total economic value of shoe recycling. For example, the separation of high quality leather in the upper part of fashion shoe from the rubber/plastic used in the sole can make huge difference in total revenue from the recycled material market. Furthermore, a range of recycling processes need to be considered due to wide ranging physical qualities, appearances, service life, and hidden value of materials used in shoe manufacture. This can be achieved through either mechanical, chemical or a combination of these processes. It is envisaged that these processes will create higher value-added recycled materials which could be used in a wide variety of applications.

Sustainable Business Scenarios for Post Consumer Shoe Recycling:

The recycled post-consumer shoe materials, regardless of their possible reuse application in footwear industry or in other industrial sectors, must compete with virgin materials both on price and performance. It is commonly reported that a sustainable recycling application heavily depends on establishing a successful 'value recovery chain' which should consider the size and the value of the end market, the current and predicted buying trends as well as the range and price of competing materials and products. At present, the cost of an environmentally friendly approach to shoe material recycling may be higher than the cost of disposing of it in landfill, but this could become competitive on the longer term due to the expected sharp rises in cost of landfilling and the emergence of the new market opportunities for recyclable materials. Furthermore, possible legislative requirements can significantly impact the economical feasibility of value recovery from post-consumer shoes. A number of business scenarios based on material types, cost of recycling and market value of recycled material as well as forthcoming legislative requirements needs to be investigated.

Appendix IV: A Summary of Discussions with Defra

As part of the actions highlighted within the workshop, it was suggested that SMART initiate a dialog with the group responsible for Defra's 'Sustainable Clothing Roadmap', and investigate potential cross-over and collaboration opportunities. Defra's Sustainable Products and Materials group as part of their Sustainable Consumption and Production (SCP) programme are trialling roadmaps to improve the sustainability performance of 10 priority products, one of which is clothing. A meeting was held on the 3rd December 2007 with Dr. Dorothy Maxwell, the clothing roadmap lead. The intended goal of this meeting was to:

- i. Identify as to why footwear consideration had not been included within the roadmap, and determine as to whether this would be incorporated within current or future investigations.
- ii. Determine whether the approaches adopted by Defra to consider the sustainability of clothing, could be used to develop direction for the consideration of footwear.
- iii. Identify possible funding mechanism for the establishment of the Footwear Recycling Working Group (FRWG).

Inclusion of footwear within current Sustainable Clothing Roadmap

It is clear from the initial discussion that the scope of the roadmap is extremely comprehensive, focusing not only on the environmental impacts of clothing, but also on the social and ethical issues relating to their production. The roadmap is intended to take a whole life-cycle view of clothing consumption, and considers the impacts of upstream supply and production right the way through to in-use maintenance and end-of-life disposal. As a result footwear and apparel have been excluded from the current roadmap due to these scoping issues, but could possibly be included within subsequent product trials if the current clothing focus proves successful.

Comparison of the two initiatives

Defra's intended objective is to provide guidance to the clothing and fashion industry by providing a forum for discussion, and to engage these stakeholders in identifying opportunities to improve the sustainability performance of clothing. Given the large scope of the roadmap, which incorporates environmental, social and ethical issues across whole life-cycle, the intended aim is to establish theme specific sub-groups (e.g. sustainable design, consumption trends/behaviour, energy efficient cleaning, end-of-life processing, etc.) so participants can pool core knowledge in each of the thematic areas. Dr. Maxwell was keen to highlight the self-directed member focus of the roadmap, and the intention for individual participants to take ownership of actions in their respective areas. Further information on the roadmap and proposed action areas are at:

<http://www.defra.gov.uk/environment/consumerprod/products/clothing.htm>

As highlighted within the shoe recycling workshop held at Loughborough, Defra had also identified the need for a more detailed evidence based approach to assist with the strategic direction of the roadmap. Defra had previously commissioned Environmental Resources Management (ERM) to undertake an analysis of existing evidence on the life cycle sustainability impacts of clothing. Within the shoe recycling workshop this was discussed as a carbon footprint analysis to provide the group with a foundation with which to inform future group strategy. Hence, it is suggested that a detailed environmental assessment should be one of the first actions of the proposed Footwear Recycling Working Group.

Funding mechanism for the establishment of Footwear Recycling Working Group

The program of activities as outlined within the position paper, for both the establishment of the FRWG and related investigative work requires a suitable funding mechanism to assist in realising its activities. At this time Defra were unable to identify a specific governmental funding initiative, but suggested further discussion with organisations e.g. the Waste & Resources Action Programme (WRAP) to implement some of the more practical activities proposed by the FRWG. The Footwear Recycling Working Group were also invited to participate in the roadmap going forward to see where synergies could be met in actions.