Barriers, Drivers and Challenges for Sustainable Product Recovery and Recycling

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Keynote Objectives

- Reflect on “Are we doing enough to combat the global concerns for the environmental degradation ?”, and if not.
- What can we do about it ? in particular in the context of :-

"Sustainable Product Recovery and Recycling“

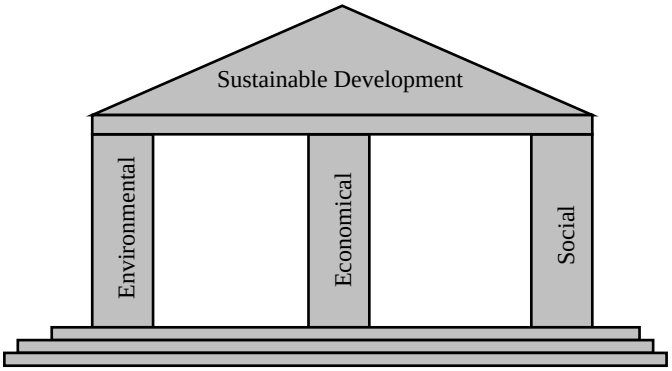
- Highlight new challenges in :-

"Flexible Automation and Intelligent Manufacturing"

Presentation Contents

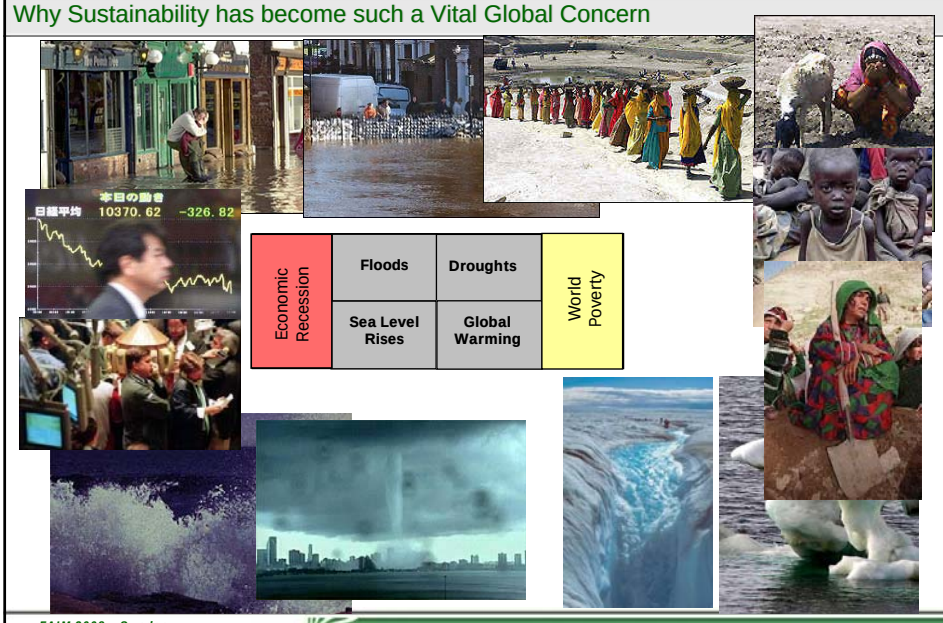
- Why Sustainability has become such a Vital Global Concern
- Scale of the Waste Problem
- Issues Related to Product Recovery and Recycling
- Drivers, Barriers, Challenges for Sustainable Product Recovery and Recycling
  - Legal Framework : Directives, Legislation,
  - Reverse Logistics and Waste Collection Models
  - Impact of Design in Product Recovery and Recycling
  - End-of-life Decision Support Systems
  - The Next Generation of End-of-life Recovery and Automation Technologies
  - Sustainable Business Models for Product Recovery
- Concluding Remarks

Sustainable Development

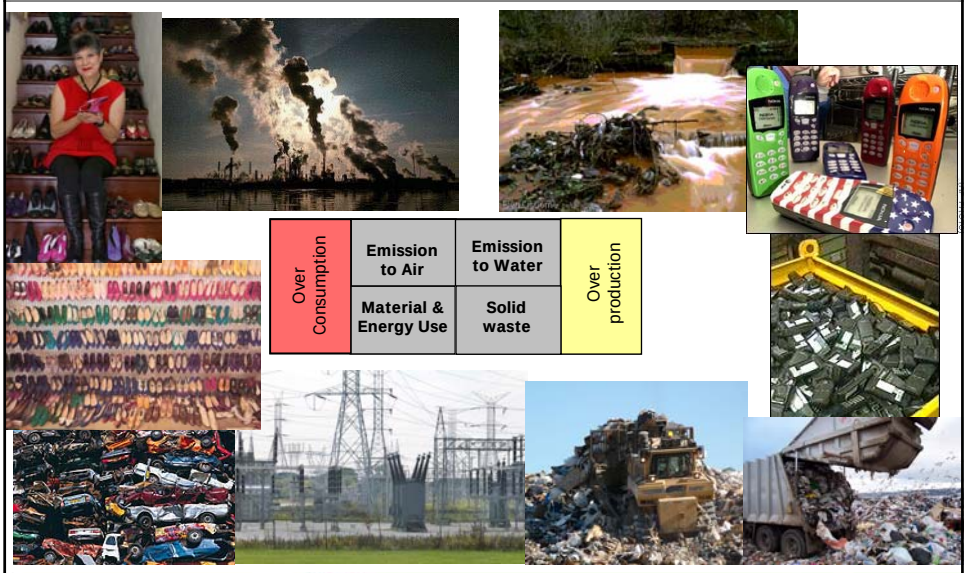


Sustainable Development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The contemporary view of this concept is based on three pillars of *Social, Economical, and Environmental* issues.

Why Sustainability has become such a Vital Global Concern



Manufacturing industry is one of the biggest sources of negative environmental impact

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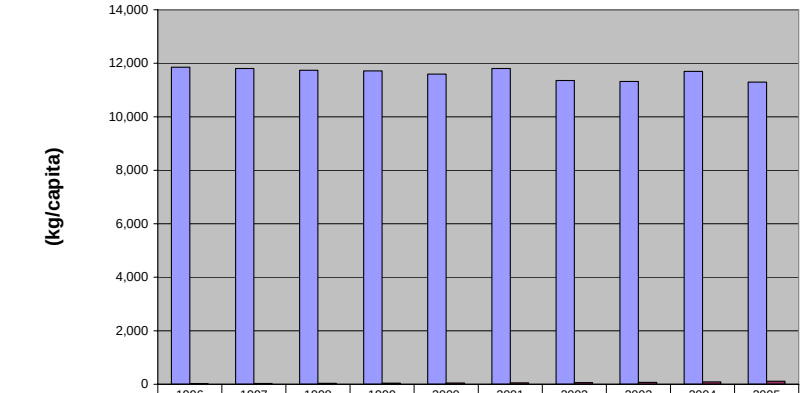
UK Domestic Material Consumption VS Material Recycling

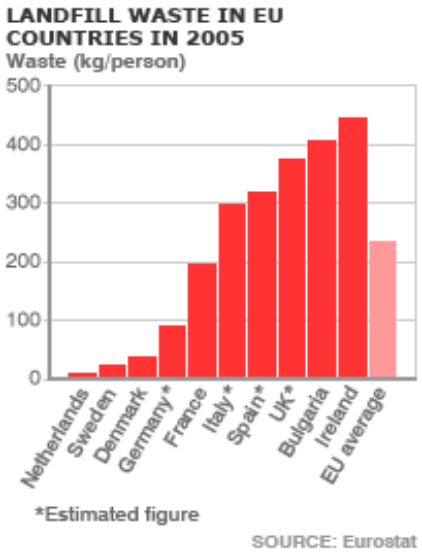


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
UK DMC/capita [1]	11,851	11,801	11,739	11,714	11,593	11,798	11,353	11,317	11,695	11,297
UK Recycling/capita [2]	27	32	36	40	48	52	60	71	87	113

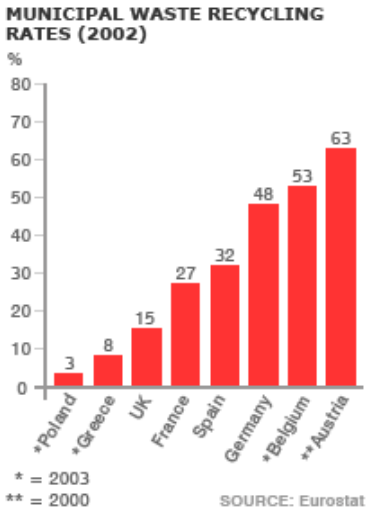
Year

Figure 1: UK Domestic Material Consumption (DMC) versus UK Material Recycling (per capita)
*DEFRA, "Sustainable development indicators in your pocket 2007",

EU Landfill Waste (Kg/Person)

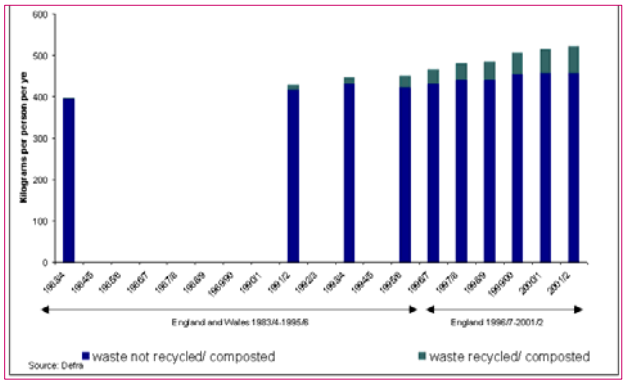


Municipal Waste Recycling Rates - 2002



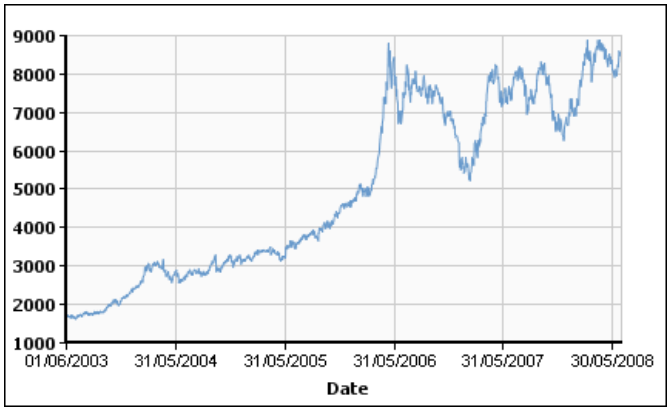
Household Waste And Recycling Per Capita in UK

Rebound Effect : The increase in waste generation is outstripping any gains made through increased recycling.



Prices of Metal Scrap - Copper Grade A

Copper Grade A (06/2003 - 06/2008)

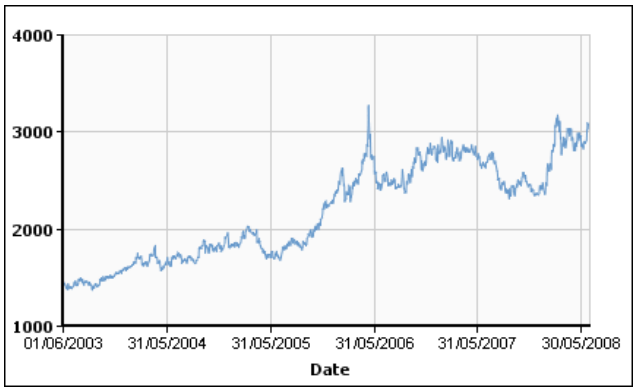


LME* Official Prices (US$/tonne)

* LME : London Metal exchange

Prices of Metal Scrap - Aluminium

Aluminium (06/2003 - 06/2008)

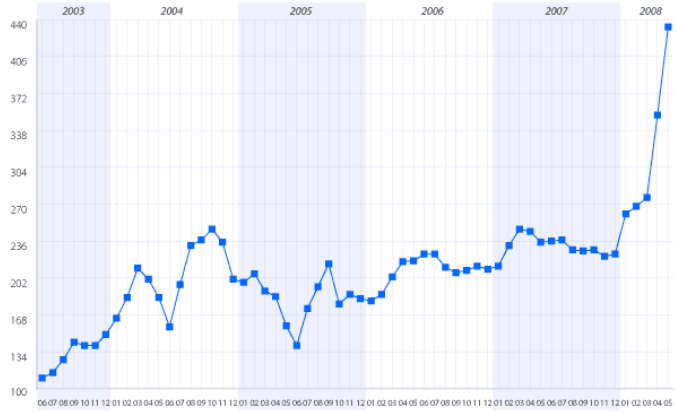


LME* Official Prices (US$/tonne)

* LME : London Metal exchange

Prices of Metal Scrap - Iron and Steel

Scrap Iron & Steel (06/2003 - 05/2008)

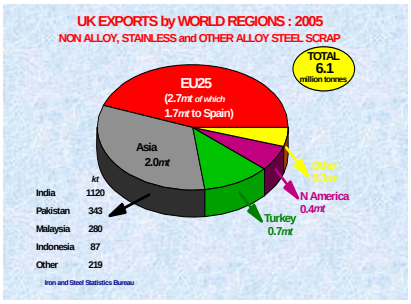


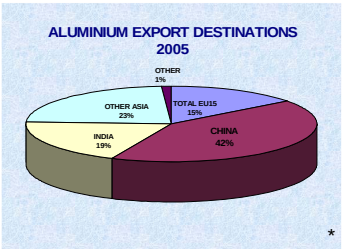
* the European Confederation of Iron and Steel Industries 2008

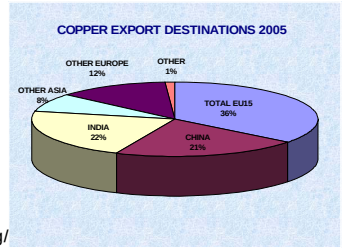
Index (2001= 100) calculated on the basis of the average price in € (1 € = 1.57 $)

for the following countries: France, Germany, Italy, Spain, UK.

The UK is one of the five largest metal scrap exporting countries in the world !

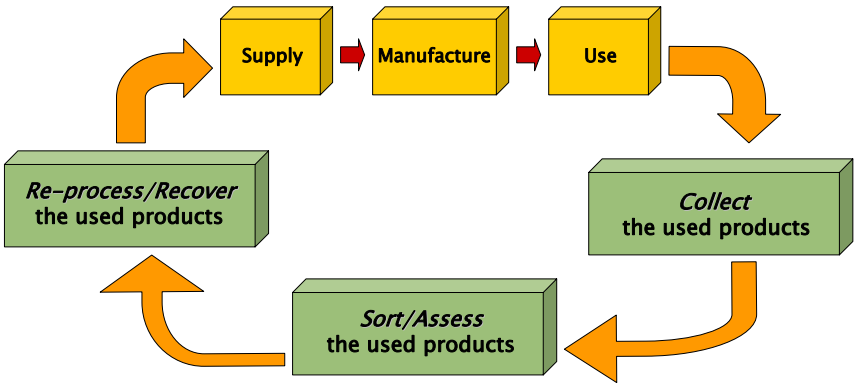




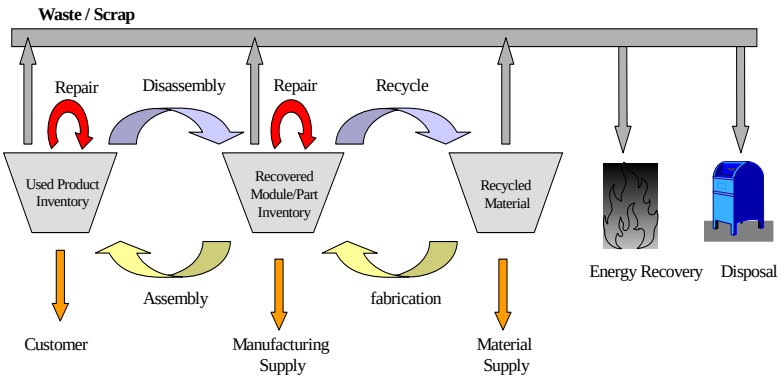


* http://www.recyclemetals.org/

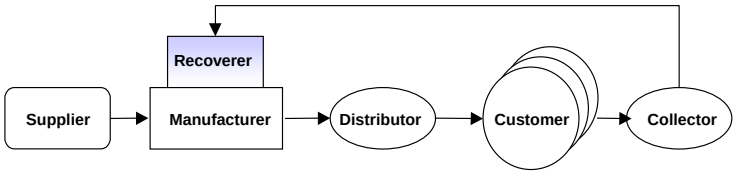
Additional Activities and Actors in Product Supply and Recovery Chain



A Holistic View of Product Recovery Options

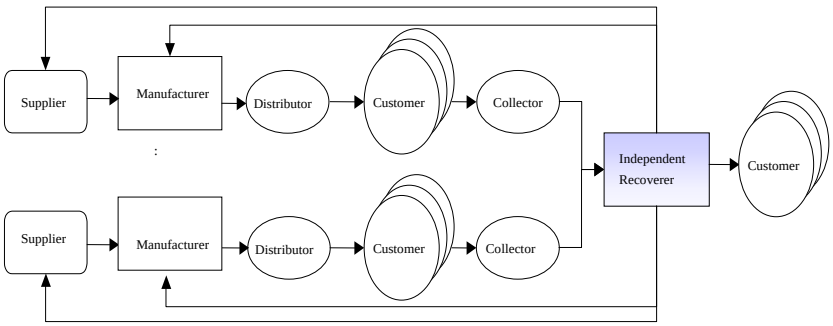


Product Recovery Practices - 1



- Used products are returned to the original manufacturer
- Manufacturing activities are expanded to include recovery operations

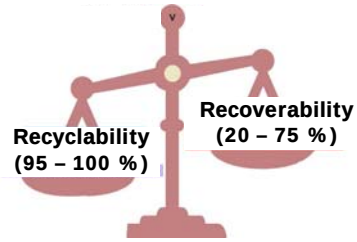
Product Recovery Practices - 2



- Independent recoverer carries out the recovery processes
- Recovered products can be supplied back to original manufacturer or be sold to any third party customer

Recoverability versus Recyclability

- **Recyclability** : Ability to remanufacture and reuse the entire product or some of its parts and components and/or to recycle its material content.
- **Recoverability** : Ability to collect, sort, disassemble the parts or components and/or to separate the materials content of a product at the end of its useful life.



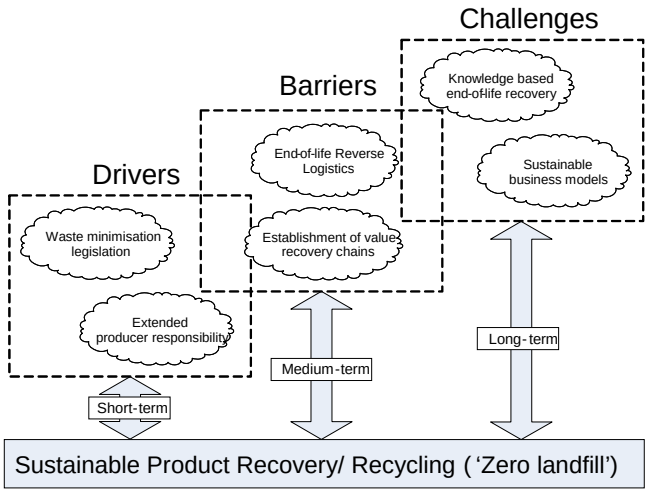
Existing Product Recovery and Recycling Applications

- Well established recovery and recycling sectors
  - Automotive
  - Packaging

- Recently established recovery and recycling sectors
  - Electrical and Electronic
  - Furniture
  - Carpet

- New/future recovery and recycling sectors
  - Textile and Shoes
  - Fuel Cells,

Drivers, Barriers and Challenges in Sustainable Product Recovery & Recycling



DRIVERS : EU Directives and Legislation

- Produce Reasonability Directives force manufacturers to take financial responsibility for take back and recycling of their products, e.g.
  - **End-of-life Vehicles (ELV) Directive** which sets recovery targets of 85% of all End-of-Life Vehicles by weight by January 2006 (minimum 80% recycling) and 95% by January 2015 (minimum 85% recycling).
  - **Waste from Electrical and Electronic Equipment (WEEE) Directive** which introduces 10 product categories with recovery and recycling targets between 50% - 80%.
- Other EU Directives :
  - Landfill Directive
  - Restriction Of use of Hazardous Substances (ROHS)
  - Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH)
  - Energy-using Products (EuP)

BARRIERS : Directives and Legislation Implementations

- Various models adopted for transposition and implementation of the EU Producer Reasonability Directives. For example in the UK
  - **"Zero Cost Contracts"** in which Vehicle Recovery Consortiums (Auto Green and Car Take Back) have accepted the responsibility of fulfilling legislative requirements with the condition that manufacturers do not charge them for their End-of-life Vehicles.
    - In most cases, this is a 10 year contractual agreement due to end in 2015 !?
    - This has impacted the manufacturers interest in improving the recyclability of their cars.
  - **"Recovery Notes**" in which the Legislative Compliance Scheme fulfill the regulatory requirements, and electrical and electronic manufacturers and retailers are charged based on their market share.
    - Similarly, this method provide little incentive for manufacturers to the recyclability of their products.
  - **"Environmental Levies for Consumer at Point of Sale"** in which the consumers pay for the cost of recovery and disposal of products
    - Debates on the legality of passing the cost burden onto consumer

BARRIERS: Reverse Logistics and Waste Collection Models

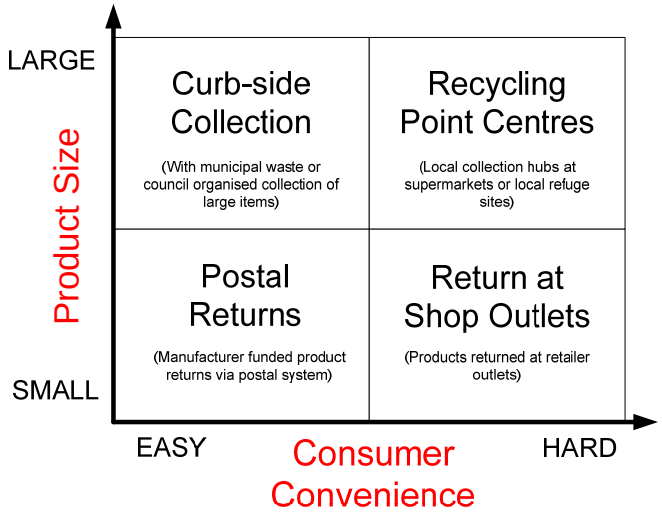
1) **Curb-side collection**: utilising the existing municipal waste collection infrastructure currently in place.

2) **Recycling Point Centres**: Geographically distributed product collection site,

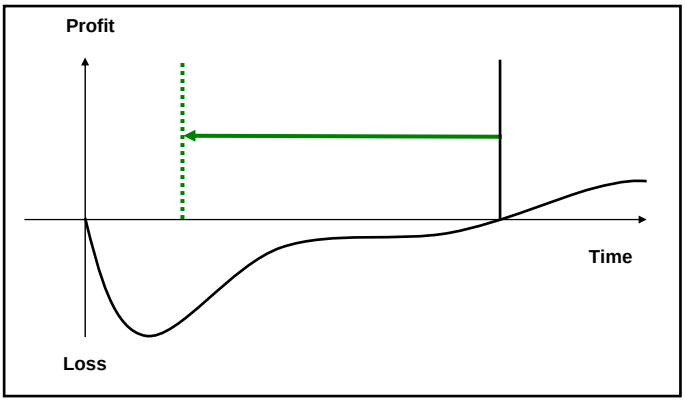
3) **Return at Shop Outlets**: return facilities at the point of original sale

4) **Postal Returns**: free-post by return envelopes for consumer goods

Waste Collection Models based on "Product Size versus Consumer Convenience"



BARRIERS: Predicted Economical Implications of Product Recovery and Recycling

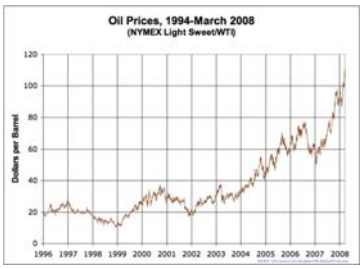


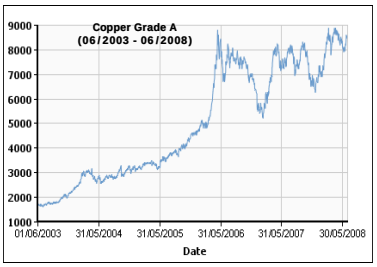
BARRIERS: Establishing Value Recovery Chains

"Push" for Increased Recycling through Legal Framework

must be converted to

"Pull" for Increased Recycling through Market Conditions





CHALLENGES : End-of-life Product Considerations to Support Design

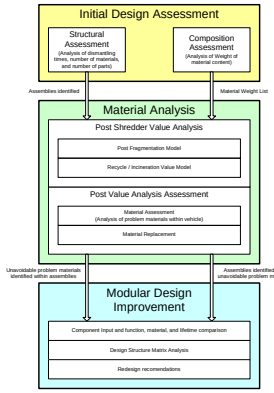
- Existing theoretical design paradigms including 'design for environment', 'design for disassembly' and 'design for recycling' **have failed to significantly increase** the recoverability and recyclability of products.
- **End-of-life knowledge** (disassembly indices, material recyclability, efficiencies of current automated separation technologies, calorific values for energy recovery technologies, etc.) must be feed back into the product development phase.
- The increased **end-of-life value recovery** will be of paramount importance.
- Hence, the requirements for the integration of end-of-life product requirements into **widely adopted manufacturing design tools and standards**.

EoL Design : Case Study _ End-of-Life Vehicle Recovery

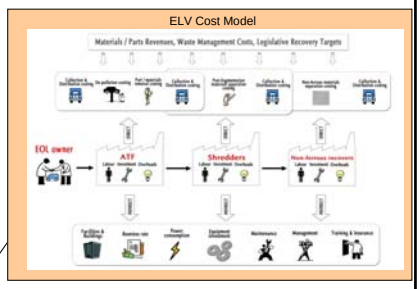
End-of-life Management

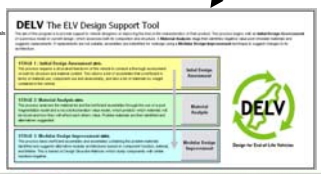
It is estimated that around 2,000,000 cars are scrapped in the UK every year, from which :-

- 1,400,000 million are true ELVs,
- 400,000 crashed/premature write-offs, and
- 300,000 are abandoned vehicles.



ELV Cost Model

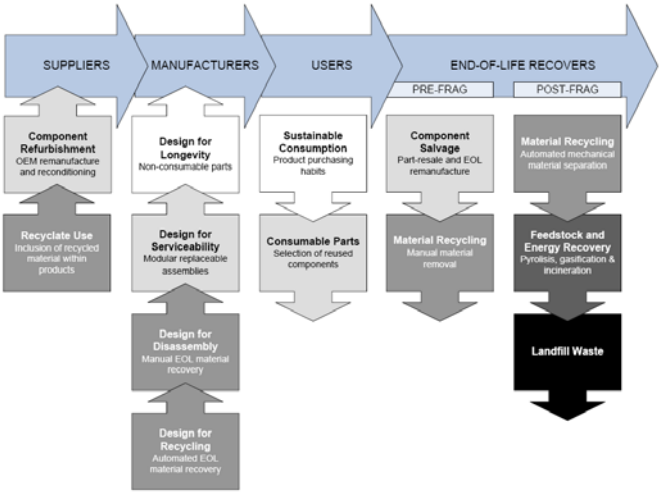




ELV Directives

- *Producer Responsibility* : vehicle manufacturers or importers to pay 'all or a significant part' of the costs of take back and treatment from January 2007.
- *Recovery Targets* :-
  - 85% of by January 2006 (minimum 80% recycling), and
  - 95% by January 2015 (minimum 85% recycling).

CHALLENGES: Resistance to Improve Design for End-of-life Recovery

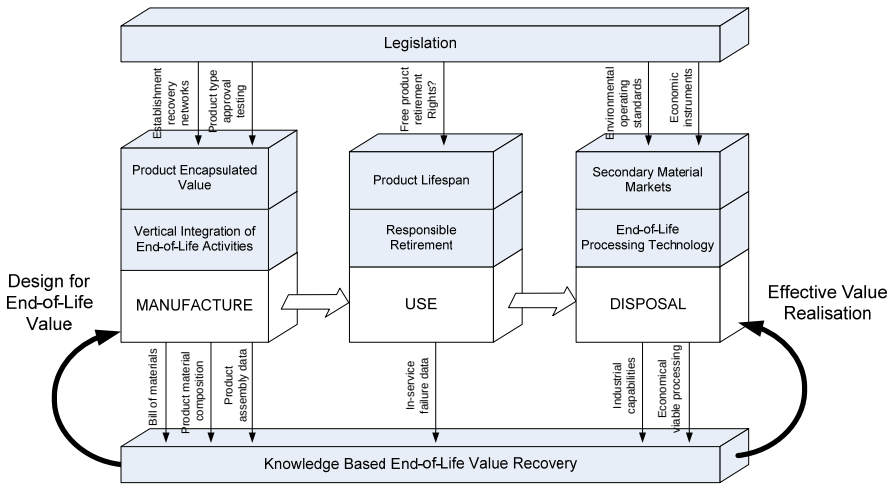


"Why should manufacturers adopt a "design for end-of-life value recovery" approach to promote sustainable product recycling, if other stakeholders are ultimately reaping the economic benefits of their design practices?"

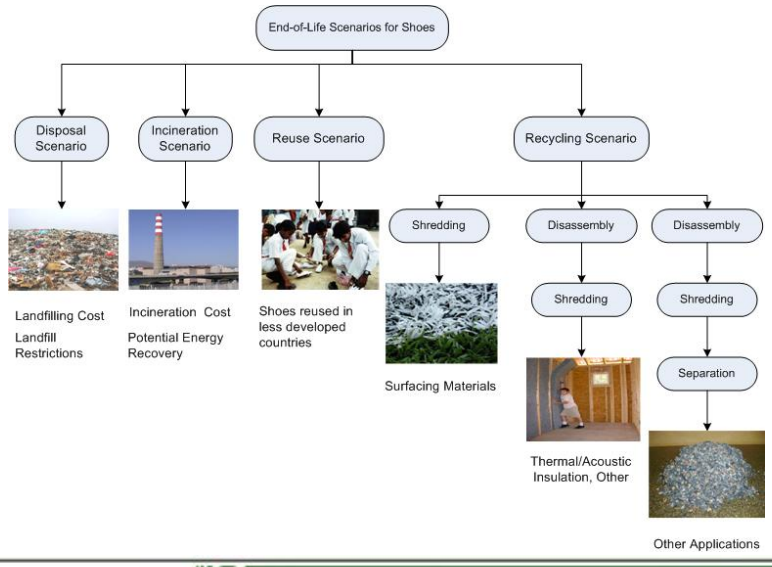
CHALLENGES : End-of-life Decision Support Systems

- The current end-of-life product processing is based on legislative de-pollution requirements followed by value recovery based on **large-scale fragmentation and separation technologies**.
- The potential to recover **additional encapsulated value** via more traditional recovery methods, such as disassembly, **have been negated due to uncertainties** in 'potential recoverable value' versus 'cost of processes and labour'.
- The existing solutions to provide **'decision support' at end-of-life** are infeasible to apply in practice or have been developed for a specific product family.
- Hence, the need to consider the most effective methods of **automating the decisions making involved in end-of-life processing** across various industrial sectors through appropriate **knowledge based systems**.

Knowledge based Systems to Support End-of-life Value Recovery

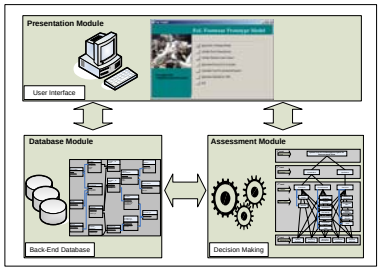


EoL Decision Support : Case Study 1 _ EoL Options for Post-Consumer Shoes



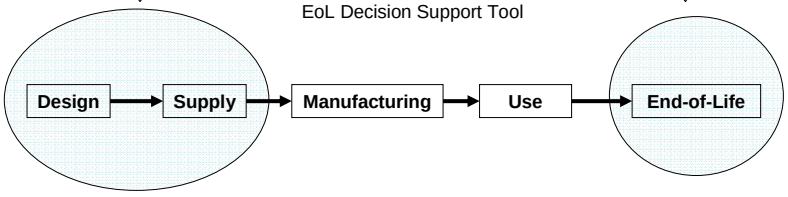
EoL Decision Support Tool for Post-Consumer Shoes

Design Optimisation and Material Selection



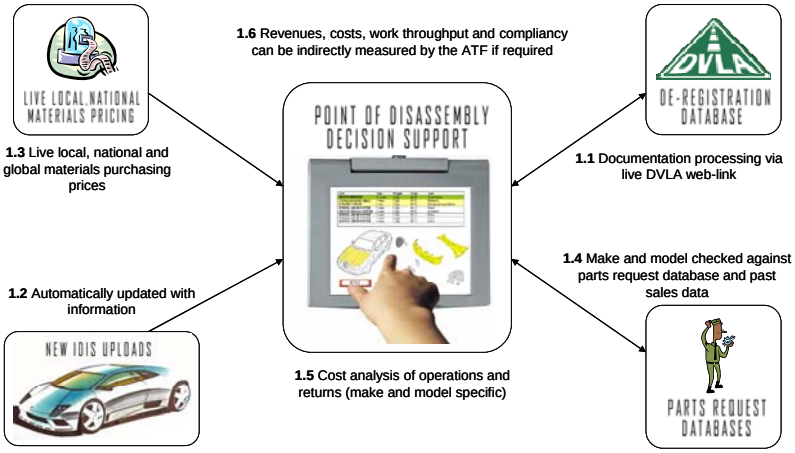
EoL Decision Support Tool

Best EoL Practise for Footwear Products

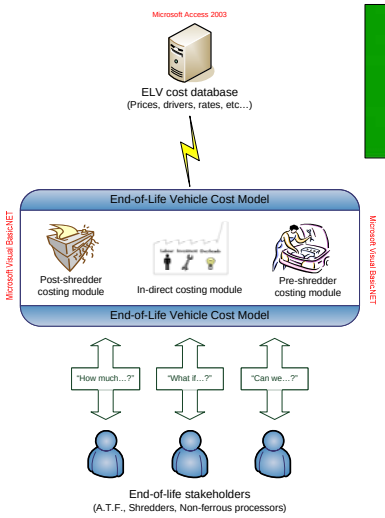


EoL Decision Support : Case Study _ Women's Fashion Boot

EoL Decision Support : Case Study 2 _ End of life Vehicle Recovery



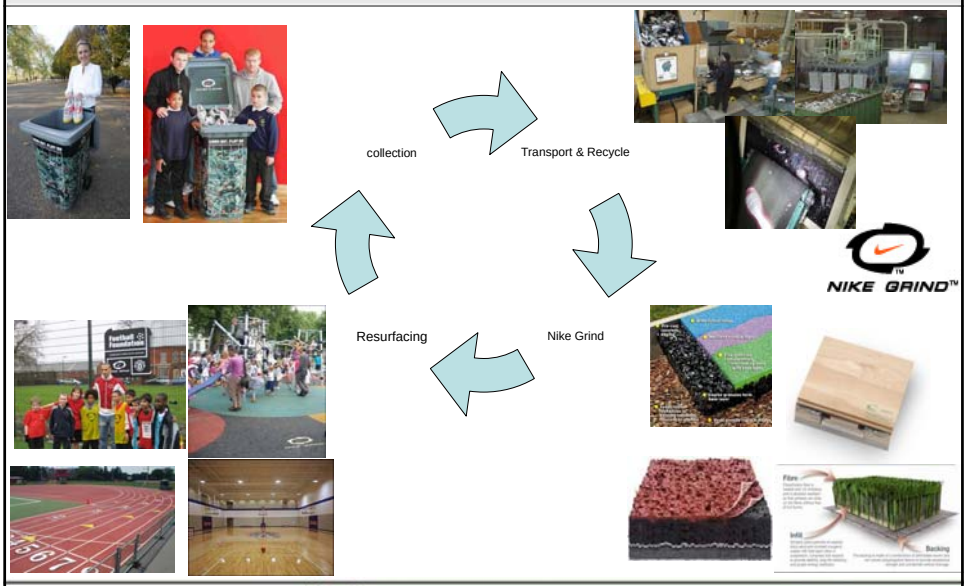
EoL Decision Support : Case Study 2 _ End of life Vehicle Recovery



CHALLENGES : The Next Generation of EoL Recovery and Automation Technologies

- **Automation is becoming increasingly necessary** in the recovery industry due to the expected growth in the scale of reclamation activities.
- To date a great deal of **emphasis** has been placed on **upstream design initiatives** (design for dismantling, design for modularisation) to facilitate part recovery.
- Yet, the reality is that the EOL **product recovery sector has moved away** from this practice and embraced more automated post-fragmentation technologies, and hence a case for **'Design for Shredding'.**
- It is widely accepted that **post-fragmentation recovery** of EOL products **is mainly in its infancy**, which highlights the requirements for a global research effort to improve automation in recycling technologies.

EoL Automation : Case Study _ Nike ReUSE A SHOE Scheme



CHALLENGES : Sustainable Business Models for Product Recovery & Recycling

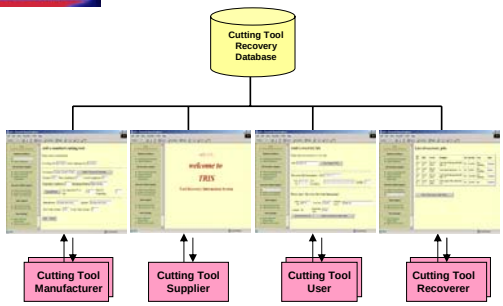
- Fundamental questions have been asked about **the long-term viability of traditional manufacturing business models based on the 'mass production and consumption of cheaply produced goods'.**
- Hence, the need for **new sustainable business models** that meets the legislative, environmental and ethical standards whilst safeguarding the future prosperity of manufacturing companies.
- These issues together with **global impact of such new business models within both developing and developed countries** requires consideration by the international research community.

Sustainable Business Model : Case Study _ Sustainable Tooling

THE QUEEN'S AWARDS FOR ENTERPRISE

Service Provision VS Product Ownership

- Integrated tool supply and recovery chain
- Business models to support tool leasing
- Sustainable use of material
- Web based information management system to support tool recycling



CHALLENGES : The SMART Approach _ Sustainable Consumption !

Best waste management approach = Avoided generating the waste in the first place

"We need to close the gap between the consumer "wants vs needs", through considerations for product personalisation, life extension, and service provision."

These photos from photographer Peter Menzel's innovative work *Material World*, show two families, one from Thailand and one from the US, in front of their homes with all of their possessions on display.

Sourced from www.menzelphoto.com

Concluding Remarks - 1

" Sustainable Development is a journey that we have just started and in this journey we **must** focus on issues that **unite** us rather than those that **divide** us."

" The question of '**Can we afford it ?'** will not have the simple monetary implications in future"

Shahin Rahimifard
Flexible Automation and Intelligent Manufacturing 2008
June 2008

Concluding Remarks - 1

" We are rapidly running out of carpets to sweep our rubbish under !!?"

Shahin Rahimifard
FAIM2008

Sourced From www.CartoonStock.Com

FAIM 2008 _ Sweden
30 June 2008

Concluding Remarks - 3

Reflect on “Are we doing enough to combat the global concerns for the environmental degradation ?”,

and if not.

What can we do about it ?

Need to Make Brave Decisions !!?

Thank you