Sustainable Manufacturing

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SMART
Sustainable MAnufacturing and Reuse/Recycling Technologies

www.lboro.ac.uk/smart

Presentation Contents

Sustainable Manufacturing (SM)

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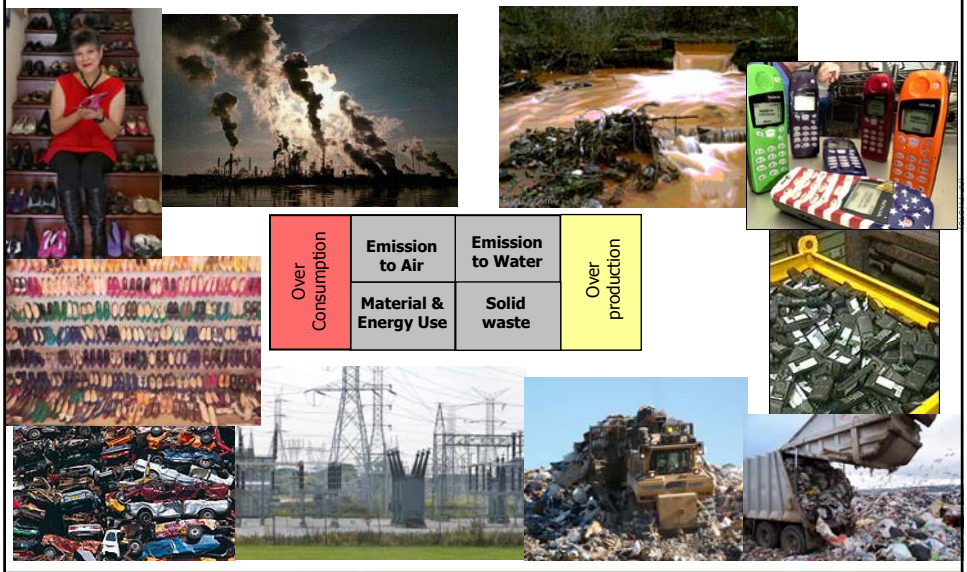
  - Grand Challenges for International Research Community

Why Sustainability has become such a Vital Global Concern

Economic Recession	Flood	Drought	World Poverty
	Sea Level Rises	Global Warming	

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

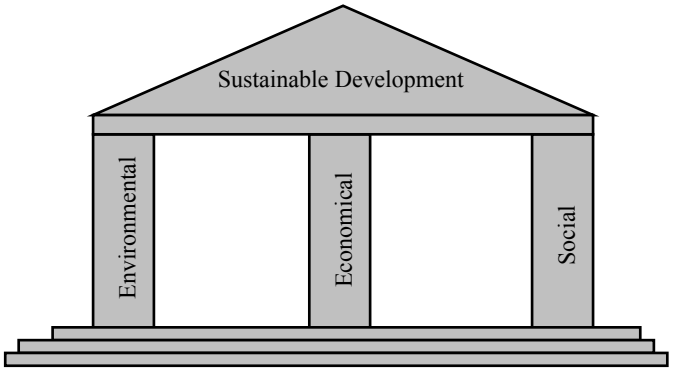


Over Consumption	Emission to Air	Emission to Water	Over production
	Material & Energy Use	Solid waste	

EU Framework 7 Manufacturing Research Agenda : MANUFUTURE

Paradigm	Craft Production	Mass Production	Flexible Production	Mass Customization and Personalization	Sustainable Production
Paradigm started	~1850	1913	~1980	2000	2020?
Society Needs	Customized products	Low cost products	Variety of Products	Customized Products	Clean Products
Market	Very small volume per product	Demand > Supply Steady demand	Supply > Demand Smaller volume per product	Globalization Fluctuating demand	Environment
Business Model	Pull *sell-design-make-assemble*	Push *design-make-assemble-sell*	Push-Pull *design-make-sell-assemble*	Pull *design-sell-make-assemble*	Pull *Design for environment-sell-make-assemble*
Technology Enabler	Electricity	Interchangeable parts	Computers	Information Technology	Nano/Bio/Material Technology
Process Enabler	Machine Tools	Moving Assembly Line & DML	FMS Robots	Reconfigurable Manufacturing Systems	Intelligent Manufacturing

Sustainable Development

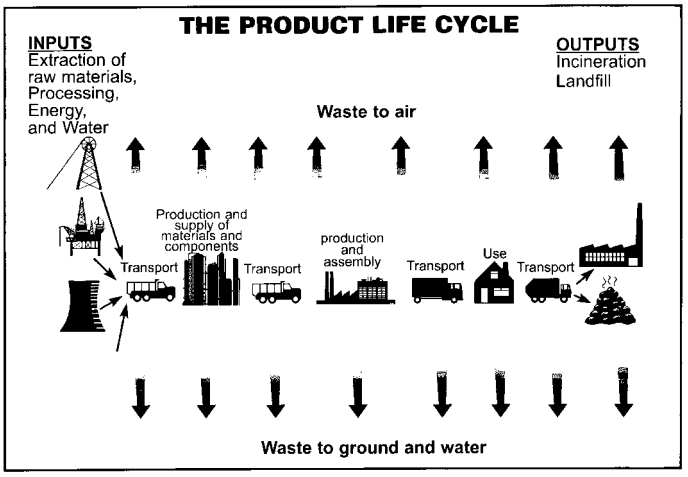


Sustainable Development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The contemporary view of this concept is based on three pillars of *Social, Economical, and Environmental* issues.

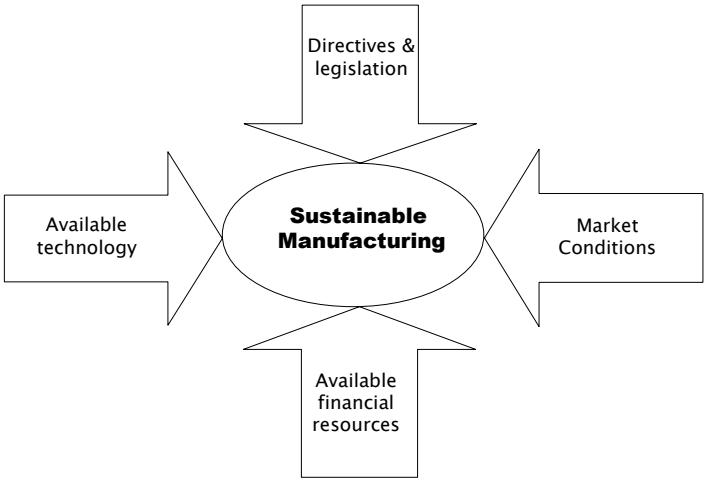
Typical Considerations in SM

Economic Issues	Environmental Issues	Social/ethical issues
➢ Financially feasibility	➢ Waste minimisation	➢ Fair trade
➢ Technological feasibility	➢ Cleaner manufacturing	➢ Equitable policies
➢ Short and long-term profitability	➢ Cleaner materials	➢ 'Good' employment
➢ Green pricing	➢ Eco-efficiency	➢ Conditions of work
	➢ Less materials	➢ Investment in communities
	➢ Less energy	➢ Support for regional economy
	➢ Renewable resources	➢ Cruelty-free
	➢ Renewable energy	➢ Satisfaction of real needs
	➢ Recycling	➢ More customer value
	➢ Product Service Systems	➢ Participation
		➢ Equality (gender)

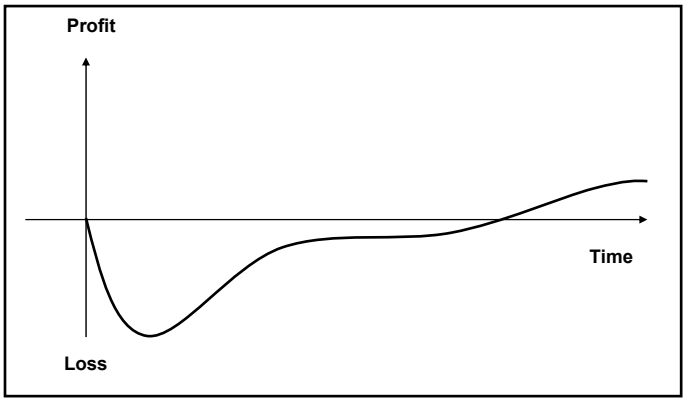
Life Cycle Thinking



Major Factors Influencing Sustainable Manufacturing

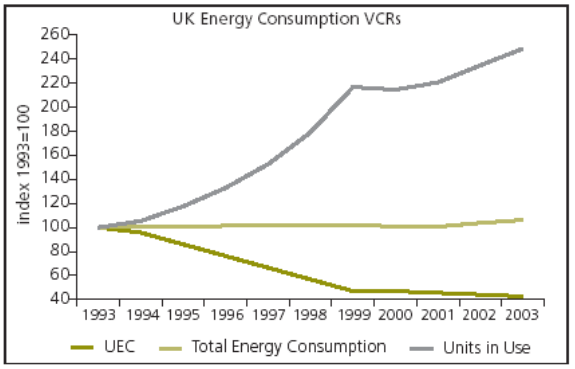


Predicted Economical Implications of Sustainable Manufacturing



Rebound Effect : Sustainable Production VS Increased Consumption

Rebound Effect is when the volume of consumer purchases is outstripping any gains made through the improved efficiency of the products . An example of this rebound phenomenon is the improvements in unit energy consumption (UEC) being offset by much higher consumption of units VHS/DVD recorders.

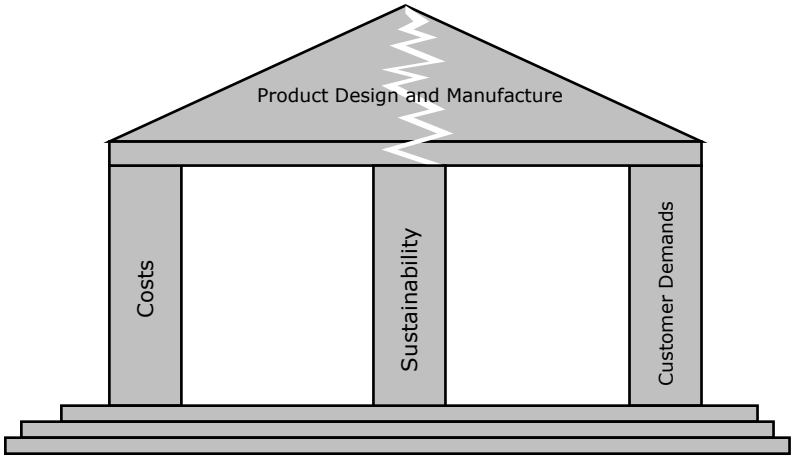


Sustainable Consumption

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.

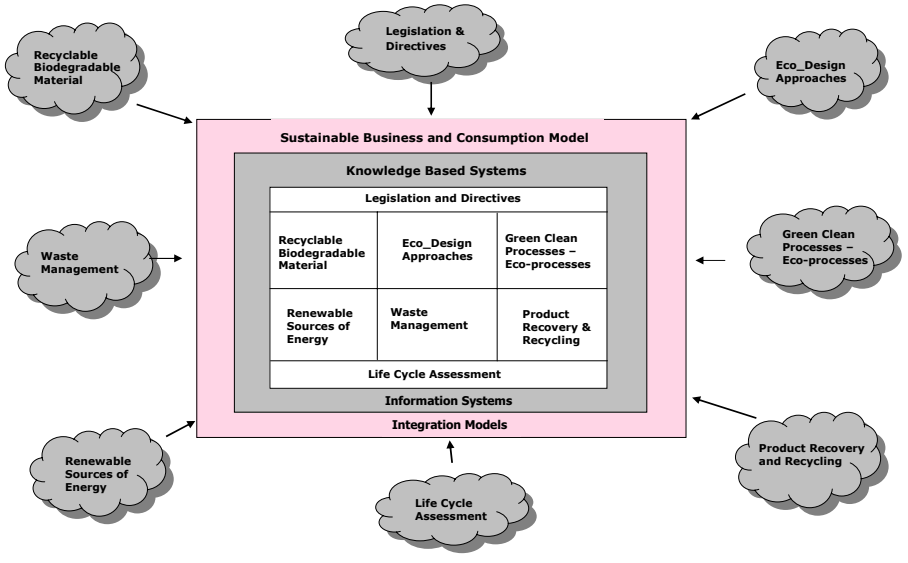
Sourced from www.menzelphoto.com

Research Assertion

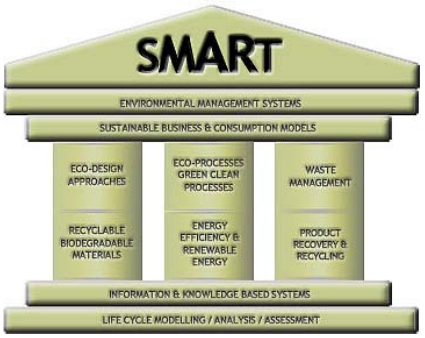


Current patterns of Mass Production of Cheap Goods and Over Consumption of Products with a Short Use Life Cycle cannot be SUSTAINED.

Research Strategy



Strategic Goal of Centre for SMART



"To develop strategies, methodologies and supportive technologies for a sustainable approach to design, production, consumption and disposal of products that meets the customers needs as well as legislative, environmental and ethical standards while safeguarding the future prosperity of manufacturing businesses"

List of Projects

Current Centre for SMART Projects

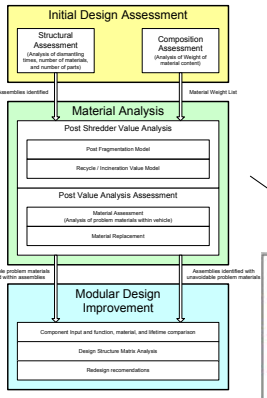
- End-of-life Vehicle
- Royce Rolls Fuel cells
- Embedded Information Devices
- Waste from Electrical and Electronic Equipment
- Sustainable Tooling in Metal working applications.
- Waste minimisation in food sector
- Customised - Environmental -Cost effective Shoe

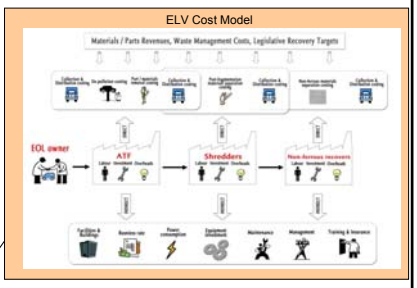
EPSRC Project : End-of-Life Vehicle Recovery

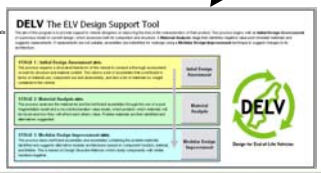
End-of-life Management

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.



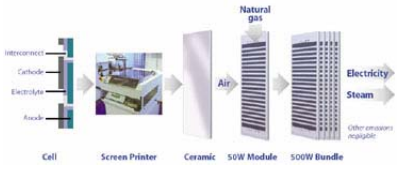




ELV Directives

- *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).

KTP Project : Sustainable Design of Solid Oxide Fuel Cells



The Rolls-Royce Fuel Cell system is lower cost; more efficient; more easily distributed; more durable and maintainable than its nearest rival.

RRFC Knowledge Transfer Project

- To identify environmental legislation that will impinge upon the manufacture, use and disposal of fuel cell
- To undertake a 'eco-design' study to optimise the sustainable manufacture, use and end-of-life processes
- To develop and implement a 'decision model' to enable designers and manufacturing engineers to minimise adverse environmental effects.

EPSRC Project : Reference Models for Embedded Information Devices

EID Project

To investigated the development of a range of smart and intelligent Embedded Information Devices (EID) to support a sustainable approach for the use and recovery of products, where :-

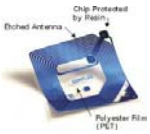
- **Smart EID** defined as having the ability to monitor sensory data and update the product with repair and exchange records, improve product functionality, etc,

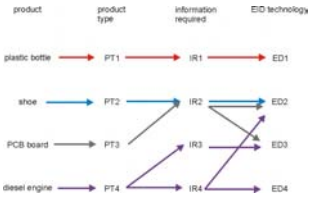
- **Intelligent EID**, which extends the Smart EID concept to the ability of the product to predict lifetime and advise projected lifetime against usage profiles with a view to optimisation of product or process life. This clearly involves adaptation to changing scenarios and meaningful dialogue with human beings.

Information Classification			
type	material	assembly	EOL option
IR1	simple	no	no
IR2	simple	simple	yes
IR3	moderate	simple	yes
IR4	moderate	moderate	yes

Product Classification			
type	material	design	function
PT1	simple	simple	simple
PT2	moderate	simple	simple
PT3	moderate	moderate	moderate
PT4	moderate	complex	simple

EID Classification			
type	format	nature	frequency
ED1	1D barcode	N/A	N/A
ED2	2D barcode	N/A	N/A
ED3	RFID	static	915MHz
ED4	RFID	dynamic	2.45GHz

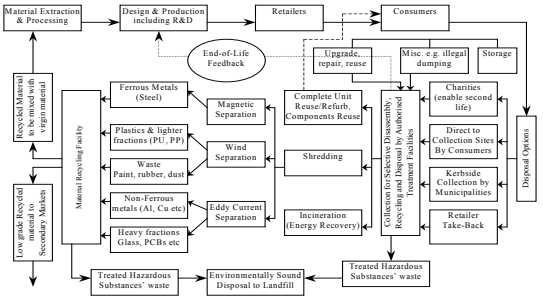




PhD Programme : Waste from Electrical and Electronic Equipment

WEEE Project

- To Investigate various End-of-Life Options for Electrical and Electronic Equipment which are Targeted by WEEE Directive
- To Realize a Decision Support System to Identify most Appropriate End-of-Life Option for particular Equipment.
- To design and Develop a Computer Aided Recycling Process Planning (CA***R***PP)

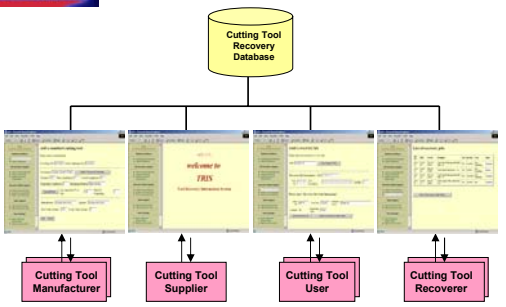


KTP Project : Business and Information Models to Support Sustainable Tooling

THE QUEEN'S AWARDS FOR ENTERPRISE

Service Provision VS Product Ownership

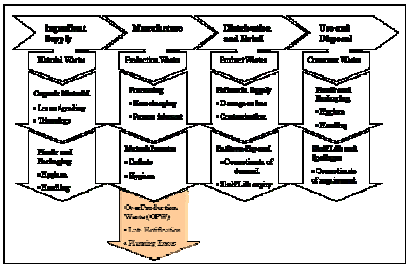
- Integrated tool supply and recovery chain
- Business models to support tool leasing
- Sustainable use of material
- Web based information management system to support tool recycling

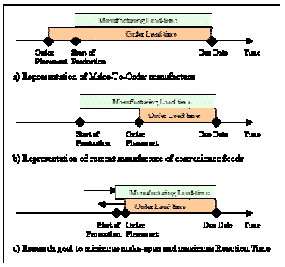


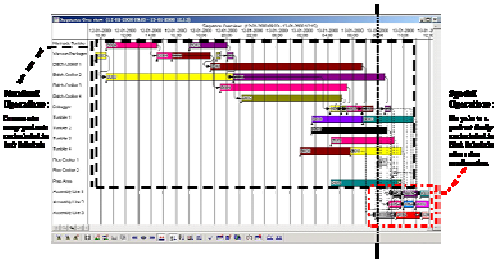
PhD Programme : Waste Minimisation in Food Sector

WM in Food Sector

- The generation of a waste model for the analytical consideration of the causes of waste generation due to inefficient operational management
- The realisation of a Responsive Demand Management framework to react to the changes in customer demand
- The generation of a novel hybrid two stage production planning approach for minimisation of waste as a result of overproduction



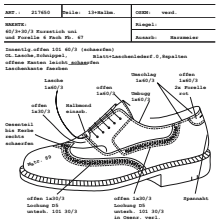


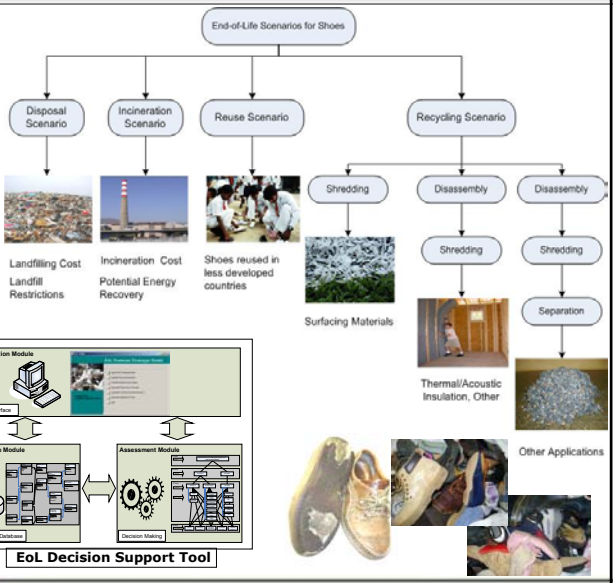


EU Project : Post Consumer Waste Management in Footwear Sector

CEC-Made-Shoe Aims

- Design for waste minimisation
- Recycling of leather
- Use of recycled materials in shoe Manufacture
- Knowledge Based eco-design tool





EoL Decision Support Tool

Centre for SMART Research Plan for Incremental R & D

- Product Design - Development of a Knowledge Based Computer Aided Design system that supports a typical designer to incorporate eco-design considerations without having to have an in depth knowledge of environmental engineering.

- Manufacturing Technologies. Development of a 'Low Carbon Manufacturing' approach which aims to incorporate the energy (and energy source) considerations as part of process selection for producing products, in particular in high volume manufacture.

- Sustainable Use and Consumption. Product development that encourages sustainable approaches during the use stage by closing the gap between the consumer "wants vs needs", through considerations for product personalisation, life extension, and service provision.

- Disposal and End-of-life. Development of semi-automated recovery and recycling facilities for various sector. Globally less than 20% of manufacturing output is recycled. The increase in required capacity to recycle various product can only be achieved through automation.

Other Potential Incremental R & D

- Nanotechnologies, and Nanomaterials
- Sustainable Use of Material
- Sustainable Packaging
- Water Engineering Solutions for Developing Countries
- Renewable Energy Sources
- Alternative Fuel (in particular for Aeronautical Sector)
- Sustainable Transportation Network
- Engineering Education for Sustainable Development.

Grand Challenges in SM for International Research Community

- Sustainable **Global** Business Models : Breaking the link between economic growth and environmental degradation whilst safeguarding social/ethical standards .
- Product Service Systems : Replacing products with services, particularly promoting eco-efficient services that minimises the quantities of natural resources they use up.
- Zero defect & Zero pollution : Quality management vs environmental management
- Sustainable Consumerism : Develop products that enable consumer to make the right choices in environmental terms.
- International Standards and Legislation that stimulate innovation and investment to provide cleaner technologies, processes and products.

Concluding Remarks

" 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
IMS Event - Zurich
November 2007

Need to make brave decisions !!?

Thank you