

LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

Sub-Committee I

WASTE REDUCTION

Memorandum by the Resource Efficiency Knowledge Transfer Network

Summary

Many of the products, processes and systems that we now employ were developed before the importance of sustainability was fully recognised. By focussing on the first level of the Waste Hierarchy the Select Committee's inquiry will examine fundamental issues that can have significant medium to long term impact on sustainability.

Whilst it is important to strive to improve on current systems it is vital that we carry out a full re-assessment of what we do, how and why we do it. This type of analysis will help us to identify more sustainable systems. We must engage individuals and organisations and motivate them to make contributions.

To fully evaluate Eco-design (Design for Sustainability, DfS; Design for Environment, DfE) there are many inter-related factors that must be considered. If a true comparison between a new product, or process, and existing practise is to be made a recognised measurement system must be in place. The comparisons that are made today usually focus on a single factor or consider specific products. However in order to facilitate global communication and dissemination of best practices it is essential that international standards for eco-efficiency/sustainability indices are developed and adopted quickly. These systems must be practical and easy for businesses to take up and for the general public to comprehend. They will provide all stakeholders with the yardstick that will enable them to assess their situation and to take the appropriate decisions.

It is important that these measures are then used to promote step change in addition to incremental improvements.

The need for rapid improvement must be communicated to the whole community. Sustainability will not be achieved by a series of technical fixes but we can become more sustainable through a combination of social measures and by adopting technology that is more compatible with the bio-sphere.

Background

We believe that it will take a concerted effort and a coherent strategy to adopt policies and to co-ordinate all of the elements of society to make effective and rapid movement to a more sustainable future. By tackling the issue of waste reduction at the design stage the House of Lords S&TSC inquiry will address issues that can have major impacts in the medium to long term. This should be done in parallel with other initiatives that focus on the more immediate 'end of pipe' waste management/disposal issues. There must be a drive to improve all aspects of the efficient use of resources and to create conditions that foster continuous improvement.

Technology alone cannot provide the solution. The wellbeing of citizens must be integrated with programmes and innovations that give careful consideration to the global situation. We need to engage with the citizens and enable them to learn and develop their understanding of the need for more sustainable behaviour. This process must re-assess the balance between the relative burdens/costs of material use with the potential/cost of human resources. If we are to live more sustainably within the constraints of the biosphere we need to adapt and to learn how to do more with less material. If we do not there is a strong probability that conflicts will arise over access to resources.

The UK will be in the best position to build a sustainable economy and contribute to improving the global situation if it is in a position to develop and demonstrate processes and products that are eco-efficient (e.g. use fewer resources, generate less waste and are compatible with the environment).

To achieve the maximum benefit the application of a Waste Reduction strategy must be a component of an integrated sustainability programme (perhaps the term Resource Management would be more appropriate).

The Resource Efficiency Knowledge Transfer Network interacts with all of the stakeholders in the community and we have attempted to capture the 'big picture'. We fully agree with the importance that the Select Committee has attached to Waste Reduction as indicated by the title of our annual conference this year ('Designing out Waste – Gaining the Advantage'). We have tried to respond to the questions raised but the fact that these are often inter-related means that the answers are contained within the relevant headings and there may be some overlap and repetition.

Better Design and Use of Materials

It is important to remember that waste does not only occur as material (solids, liquids and gases) but also in the form of other resources such as energy, finance, human, land, opportunity, etc

Although we should not get bogged down in semantics it is preferable to consider materials that are not the main output of a process as 'by-products' rather than wastes. These by-products become waste if they cannot be utilised effectively. An efficient process will minimise the resources utilised and the volume of wastes generated.

Many existing industrial processes have been developed and optimised over a number of years and so the scope for efficiency improvements in them is generally limited to incremental gains. Conventional process optimisation has tended to focus on local (factory unit) issues rather than encompassing 'the bigger picture'. Approaches to waste management for example tend to be driven by expediency, dealing with waste arising, rather than seeking fundamental solutions that would eliminate or reduce waste generation. In the past the tendency has been for design to walk the tightrope between cost and function. As new legislation takes effect and the availability of disposal facilities declines the cost of the disposal option is increasing. This motivates business to take 'cradle to grave' life cycle impacts into account. Key management information and decision making tools will be required together with a suitably qualified workforce to make businesses sustainable. The optimisation of existing processes should not be abandoned because there are still gains that can be made in the short to medium term. However step changes can only be achieved through the development of new technologies and/or approaches.

We believe that the sustainability aspects of a product or process must be considered at the design stage because this is where the most impact can be made – it has been estimated that 80% of the overall product / process life cycle costs (financial, material, environmental) are determined at the design stage. Thus it is far more effective to design out waste at this stage rather than to treat it, retrospectively, at the end of pipe.

In the past products have been developed taking the following factors into account: -

- Specification/Performance
- Specific cost (per unit of performance)
- Availability (price variability)
- Aesthetics (where these are relevant)
- Marketability (can the product be delivered profitably)

As environmental and waste management regulations have been developed and adopted these have started to impact on process costs and have become part of the equation (albeit from the view of complying with regulations rather than from a desire to be more sustainable).

The rather segmented or 'silo' approach to our education and training systems has meant that it is rare to find individuals with all of the necessary skills. However with modern ICT systems it should be possible for project managers, designers, or design teams, to ensure that due consideration is given to sustainability. For the design process to be effective it is important that all of the players in the design team have an understanding of the principles of sustainability. Institutions such as the Royal Academy of Engineering and others (IMechE, ICE, IChemE, IOM³, etc) are supporting developments in this area and the concept of sustainability is being developed in Primary and Secondary education. It is important that these initiatives and programmes are endorsed and expanded so that sustainability is a concept that is understood by all and becomes a part of their approach to life.

The role played by design and materials is a bit similar to the chicken and egg situation. It is possible to conceive of a design for a chicken or, as Bessemer did in 1856, of an oxygen converter for molten pig iron, however it was not until the appropriate materials were available that the concept could be realised (nearly 100 years later). Thus the development of new technologies and materials are interdependent and essential for more sustainable designs.

What is vital now is for the design team to take sustainability into account during the development of products or processes.

The things that need to be considered include: -

- The environmental impact of producing the input materials/components
- The environmental impact of the process/product during 'service life'
- The fate of the products/components at the 'end of life'.

There are however problems in obtaining the appropriate information for selecting and evaluating a product or process on the basis of sustainability. There are various claims made about eco-efficient products. Some products have been classified according to single factor performance ratings (e.g. Energy Ratings for electrical goods, CO₂ emissions for automobiles) however these do not give the whole story. There are several agencies trying to develop appropriate standards based on the concept of Life Cycle Analysis (LCA) such as the UNEP/SETAC programme that is being supported by the EU¹;

At present these systems are complex and not straightforward for businesses or individuals to access. The EU is looking at ways of establishing appropriate measures and standards as part of their action plan for Sustainable Production and Consumption and Sustainable Industry Policy. The Japanese are working in this area with a NEDO (New Energy and Industrial Technology Development Organisation) grant funding a project for the International Development and Standardisation of Environmental Information Indices for Materials. The scope of this project is defined as: -

"Coexistence of economic health and reduced environmental burden is essential to sustainable development of our societies. In order to reduce the environmental burden of industrial products in a free trade system, we must develop the international indices for disclosing environmental information of traded materials and standardize them internationally for buying and selling. In this project, Japan leads the international development and standardization of the indices and the open framework for the indices to construct a foundation for sustainable development"².

Until the appropriate measures and standards are in place the concept of Life Cycle Thinking and Integrated Product Policy are being developed³.

¹ See <http://www.unep.fr/pc/sustain/lcinitiative/home.htm> (See also the International Standards Organisation, with the ISO14040 series of LCA standards).

² see: <http://www.nedo.go.jp/english/archives/170927/attach.html>

³ see: <http://www.europarl.europa.eu/sides/getDoc.do?language=EN&pubRef=-//EP//NONSGML+TA+P5-TA-2004-0349+0+DOC+PDF+V0//EN>

In addition to the factors given above the designers must consider: -

- Design for minimising resource use (commensurate with performance)
- Design for process/product efficiency
- Consider appropriate design life
- Design for environmental impact
- Human/Social Considerations (Health & Safety)
- Design for material compatibility (in use and for re-use)
- End-of-life considerations
- Design for re-manufacturing
- Design for repair
- Design for dismantling
- Can recycled inputs be used?
- Are substitute materials available?

The EU appears to be moving towards the concept that taxes on material consumption should be increased and those on employment should be decreased.

The question 'Can better designed products offset the increase in consumption?' is really the wrong way to approach the problem. It implies that the trend for increased consumption is inevitable. Is this necessarily the case? Can continued growth be sustainable in itself, given the huge populations in developing nations such as China and India? The seminal work 'Factor Four, Doubling Wealth, Halving Resource Use'⁴ puts the case for a fourfold increase in resource productivity. This is now considered by many to be a minimum aspiration, and Factor X is frequently cited as a necessary objective to enable sustainable 'one-planet' living, since the developing nations aspire to the standards of living attained in 'the West'.

We must also reflect on the meaning of the word consumption. This is not straightforward because the precise meaning can depend on the context in which it is used. In a social context the 'Consumer Society' is associated with a throw-away culture. In financial or economic terms the definition has been given as: -

Using a product or service until it has no remaining value

The using up of goods or services, either by consumers or in the production of other goods

In terms of the environment the following definition has been proposed: -

"Consumption consists of human transformations of materials and energy. Consumption is environmentally important to the extent that it makes materials or energy less available for future use, moves dynamically stable biophysical systems toward a different state or, through its effects on those systems, threatens human health, welfare, or other things people value".⁵

Without getting too tied down in definitions it is clear that in some cases a resource may undergo a significant change when it is utilised. For example hydrocarbon materials undergo a complete change in characteristics when they are used in combustion processes. Other items that are currently considered to be at the post-consumer stage do not even have zero value at the end of their design life. Many materials such as metals have significant 'value' at the end of their service life – which is why the scrap metal industry has developed into a global business.

R Ayres *et al* have developed the concept of Exergy to help account for the 'value' that may be present in materials and systems (see 'Sustainable Metal Management' and 'An Application of Exergy Accounting to Five Basic Metal Industries').

⁴ A Lovins, et al 1997 ISBN 0-13-046713-8

⁵ See: <http://www.iisd.ca/consume/stern.html>

T Graedel and others⁶ have developed the concept of Industrial Ecology: -

“Industrial Ecology is the means by which humanity can deliberately and rationally approach and maintain sustainability, given continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a system view in which one seeks to optimise the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimised include resources, energy and capital”.

The growth in consumption resulting from the development of new economic powers (e.g. China & India) will have implications for the biosphere (climate change concerns). If ‘consumption’ patterns in these economies match the demand in the developed countries, in terms of specific consumptions rates (kg/person), this will lead to material shortages in the future. This could result in conflicts over access to resources; increased competition for access to ‘natural resource’ is a factor considered in military future scenario planning, see ‘The DCDC Global Strategic Trends Programme 2006 – 2036’⁷.

Thus the urgency for improved design for resource efficiency and sustainability is important at the national and global level. It is important that international collaboration makes the best possible use of the resources that are available in this area of research and expertise. The UK has a well established academic base and world class companies so the aim should be to grow the knowledge base in this area to ensure that the UK can play a significant role in this field.

Business Framework

In the past business may have considered environmental legislation as an imposition of cost on their operations. They are now more aware of their image and the public perception of them in terms of their environmental stewardship and Corporate Social Responsibility. In the past environmental legislation has been imposed on businesses by public agencies and business has not always felt fully engaged in the development of legislation. Regulation appears to have been introduced in a haphazard way without a clear overall strategy or emphasis on the most important factors/sectors.

Businesses are starting to consider their environmental performance and the potential liabilities. They are engaging with environmental authorities to develop workable legislation (such as the disposal of ‘end-of –life’ products and materials). However until suitably qualified engineers and managers, with background knowledge of Sustainable Engineering, come through the system businesses will need the support of government programmes (such as the National Industrial Symbiosis Programme – NISP, Envirowise, WRAP and the Knowledge Transfer Networks).

The social, geographical, economic and demographic conditions in Japan are such that Japanese businesses have taken a leading role in the way global businesses can address sustainability issues. It is important that uniform international Eco-efficiency standards are developed and applied. They have accepted sustainability as a central part of their business strategy and a large home population helps them to develop new methods and practises.

Businesses have to design products and processes that are compliant with the relevant national regulations. Clarity and uniformity are important and the regulators and business should work to get together to identify the areas where the biggest impacts on sustainability can be made. Rewards in terms of allowances or tax refunds should be considered as ways of promoting improvements in the eco-efficiency of a product or a process.

⁶ T E Graedel & B R Allenby - Industry Ecology – 2003 ISBN 0-13-046713-8

⁷ see: <http://www.dcdc-strategictrends.org.uk/viewdoc.aspx?doc=1>

Business areas and industries that are dominated by large companies or multinationals are already responding to the 'Greening' of demand. As a result of WEEE, REACH and other legislation manufacturers are taking a closer look at the materials used in the production of their products. The whole supply chain needs to be involved in the design process and the Government might wish to provide appropriate support for getting this message across to SMEs in the UK.

Even though products may be manufactured elsewhere British companies could play a significant role in developing 'Green' designs. For example a company based in Cambridge (Granta) has developed an international presence in the field of Material Selection and Intelligence⁸.

Government Policy

The Government has initiated educational programmes at different levels and provides business support programmes at the national and regional levels. It is important that these can be co-ordinated effectively so that the maximum benefits can be derived. Sustainability needs to be integrated as a core element of the education process.

The NISP programme is considered by ETAP to be an Eco-exemplar programme and other countries have consulted with them. Britain should learn from the experience and best practises in countries such as Japan, Germany, Holland, Sweden and Denmark.

Programmes that encourage businesses to co-operate to make the best use of facilities and by-products, like Envirowise and NISP provide support in these areas. The issues arising from the waste definitions are a problem because these can be barriers to the utilisation of by-products (bureaucratic regulations and administration costs). The Environment Agency's move towards risk based management should be encouraged and businesses should work with the EA and other stakeholders to develop co-operative programmes that can improve sustainability.

The Technology Strategy Board can provide guidance on technological areas where the UK can compete in global markets. Through its collaborative research and Knowledge Transfer Networks it is providing support for more rapid and effective deployment of innovation.

Funding initiatives such as the Carbon Trust programme can be useful but these programmes must be sufficiently flexible to help to bring innovative technologies and processes to the market. If the UK is to develop the lead in new technologies there must be ways to support the demonstration of processes that are new and carry risk profiles that may not attract private finance. Collaboration between Regional Development Agencies and other programmes should be co-ordinated towards this goal. It is important that EU regulations that are supposed to prevent unfair competition do not inhibit projects that could make significant contributions to sustainable development.

The UK Government will have responded to the recent EU consultation which aims to develop coherent action plans for Sustainable Production and Consumption and Sustainable Industrial Policy. If EU funding can be used effectively it will allow UK projects to compete with those funded in Japan and the US. The policies and programmes in Japan would appear to be the most developed although there may be lessons that can be learnt in specific areas from other areas such as California, Japan, Germany, etc. There are several on-going projects in Europe under the UNEP Marrakech Task Force programme⁹.

It is unlikely that better product design will have a significant impact on consumer behaviour without the appropriate information and education programmes. These products can appear to be too costly for widespread adoption. Some form of support and/or tax concessions might be necessary to kick-start 'Lead Markets'. The Council for Science and Technology (CST) has recently conducted a review of technology

⁸ see: <http://www.grantadesign.com>

⁹ see: <http://www.uneptie.org/pc/sustain/10year/taskforce.htm>

areas where the UK may be in a position to compete on a global scale. Eco-design should be one such area since the design industry in the UK is considered to be being world class.

Research groups funded by the Research Councils like RESOLVE run by Professor Tim Jackson at the University of Surrey and the 'Network of Product Lifespans' run by Dr Tim Cooper at Sheffield Hallam University are looking at the social aspects of sustainability¹⁰.

Marketing strategies are clearly important. Modern advertising has tended to focus on developing sales volume. The constant development of new designs, pattern, models and gadgets has tended to fuel the 'consumer' or 'materialistic' behaviour. Can market strategies that focus on eco-efficiency and 'de-materialisation' be made to be more effective? To do this they may need to sell service rather than products (a car that will run at certain efficiency levels for 250,000 miles for example sold at a price per mile). Rolls Royce strategy for selling aircraft engines is moving in this direction (selling power by the hour). Xerox are another well known example, providing a document copying servicing while retaining ownership of the copiers themselves, allowing units to be remanufactured at the end of their first life and subsequently sent back out into service as new multiple times; representing on each occasion a saving of 92% by weight of material compared to being sent to landfill. The Research Council funded BRASS research group lead by Professor Ken Peattie (Centre for Business Relationships, Accountability, Sustainability and Society) was established to develop understanding and promote the vital issues of sustainability, accountability and social responsibility, through research into key business relationships¹¹.

Skills

Professional Institutions and organisations such as the Royal Academy of Engineers, have been active in promoting sustainable engineering and others such as, the Institute of Mechanical Engineers, Institute of Chemical Engineers, Institute of Civil Engineers, etc also have sustainability programmes. The Institute Materials, Minerals and Mining sponsor material based design courses and competitions for schools and university students.

It is important that the whole population should be mobilised so sustainability should be taught across the whole education system. Instilling awareness of sustainability at an early age would be an effective way of impacting on the behaviour of future generations.

The Design Council provide useful support for business and have published a guide to sustainable design which includes examples¹².

If international standards for eco-efficiency can be agreed then specific programmes for the rapid dissemination and utilisation of these throughout the UK business community would be vital. The Resource Efficiency KTN is actively supporting these developments through work with a UK – Japan workshop and the Brussels based Resource Efficiency Alliance.

Another source of useful information and an excellent centre for research and training comes from the Centre for Sustainable Design where Professor Martin Charter is based¹³.

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¹⁰ see: <http://www.surrey.ac.uk/resolve/> and [Network on Product Life Spans](#)

¹¹ see: <http://www.brass.cf.ac.uk/about.html>

¹² see: <http://www.design-council.org.uk/en/About-Design/Business-Essentials/Sustainability/>

¹³ see: <http://www.cfsd.org.uk/>