

DRAFT DISCUSSION PAPER

SUSTAINABLE PRODUCT DEVELOPMENT AND DESIGN (SPDD)

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Introduction

The earth will have 50% more people within 40 years - each wanting higher standards of living. This will mean a greater use of energy and resources and more emissions creating potentially serious risks to human well-being and natural systems (1). The need to balance economic development with environmental protection is becoming increasingly self-evident. However, much of discussion about sustainable development has primarily been held within the corridors of academia and government, with much of the thinking inaccessible. What is clear is that there are a range of opportunities and threats arising from the sustainability conundrum, but these are clouded in uncertainty.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs.

Source: Our Common Future, Brundtland Commission, World Commission on Environment and Development, 1987

If we are to start to tackle these significant challenges, new types of products and services will have to be developed through more sustainable forms of production and consumption. The majority of discussion has related to environmental sustainability, whilst neglecting broader ethical and social questions. The Brent Spar issue made it clear that society does not necessarily believe the science, and the social and ethical dimensions are essential parts of the sustainability debate. Sustainable product development and design (SPDD) is about considering e3s issues in the development and re-development of new and existing products: economic (e1); environmental (e2); ethical (e3); and social (s) issues. The holistic viewpoint particularly the inclusion of 'softer' ethical (e3) and social (s) issues is new and unclear due to the lack of information and judgemental nature of the problems.

(INSERT 'BLUE SKY' DIAGRAM)

Present thinking focuses on e1e2 issues, which is eco-design or 'design for environment' - either as a systematic process or an ad hoc approach i.e. 'design for dismantling' (2). But, in reality most SPDD activity relates to product re-design or to the development of eco-efficient products - i.e. products that use less energy and materials, whilst attempting to 'add (more) value' to customers.

e3s model

e1	e2
e3	s

Sustainable development does not just involve e1e2 efficiency improvements, it is about improved 'quality of life' for stakeholders through the creation of new solutions incorporating e3s considerations. Environmental sustainability is driven by suggestions that there is a need to move towards Factor 4, 10 or 20 levels of energy and resource reduction. 'Factor 4' improvement implies reducing the amounts of energy and resources needed to deliver products and services to consumers and the pollution generated by at least 300% over the next 20-30 years (3). The magnitude of the change is uncertain, however what is certain - from an environmental perspective - is that significant energy and material reduction is required - 'Factor X' reduction. However, energy and material reduction are only two elements of the discussion. The former analysis suggests less consumption, less production, 'more from less' and possibly less products and services. But, if social and ethical elements are considered then there are wider implications, such as whether organisational processes used to deliver products or services are 'good' or 'bad', how many jobs will be created in the product development process and will a move towards a sustainable world mean less choice or different choice?

Sustainability: key issues

- education
- stakeholders
- economic structures
- partnerships
- leadership

On a global scale this is leading to a clear tension between the trend to globalisation and the deep sustainability argument for localisation. Economic globalisation exacerbates the trend of the rich getting richer and the poor getting poorer by developing countries offering transnational corporations (TNCs) cheap labour and resources, and less stringent environmental regulations. However, there are growing pressures for TNCs to act a more socially responsibly in both developed and developing countries e.g. implementing environmental policies throughout worldwide operations. Consideration of social equity means that all people should have fair access to resources that improve the 'quality of life' - on a global level and at a local level. Today's generation has an ethical obligation to leave an equivalent resource base, and increased security for future generations. At the rate the world is currently using and degrading resources and ecological systems, the path to inter-generational equity is uncertain.

At present, there is no clear theoretical or practical framework as to what SPDD means for companies within the industrialised world. For example, what does SPDD mean for a company with 10,000 products, with 1000 key suppliers, who manufactures and sells worldwide? Is this fundamentally unsustainable? or are there strategies that can be employed to reduce the impact of products and services across the e3s agenda?.

To progress towards sustainability does it mean:

- movement to an intermediate, appropriate or low-tec scenario of producing and consuming locally? or differently?
- a hi-tec scenario of information-technology products and services dominated by dematerialisation?
- a shift to a world dominated by lower consumption and ‘more from less’, with the wider implications for employment, changing work patterns and ‘quality of life’?
- or does it mean a hybrid of all three?

Sustainability: some key issues

- **satisfying real needs**
- **improved ‘quality of life’**
- **alleviation of poverty**
- **democratisation**
- **self sufficiency**
- **equitable access to resources**
- **accountability**
- **self-determination**

Re-thinking and new thinking

If we are to move towards sustainability, we need to imagine what a more sustainable world will be. Most of us really haven’t thought that through. Quite understandably, the majority of people do not understand the academic concept of sustainable development. Indeed, research for the Department of Environment in the UK (4), indicated that ‘sustainable development’ was seen as a government construct to keep the ‘general public’ out of environmental issues. However, if we re-phrase the question and ask people what sort of world they would like to live in, we are likely to come up with some answers that are likely to be entirely consistent with expert viewpoints of sustainability. Sustainability is not just about re-arranging the eco-designed deckchairs, it is about questioning the purpose of the ship. It will require re-thinking and new thinking.

(INSERT 4RS DIAGRAM)

How do we translate these issues back into something applicable to product and service development and design? A key issue is that we must not forget that customers (domestic, intermediary, and ‘business to business’) buy products for the *service(s)* they provide. A re-direction away from conspicuous consumption, is likely to mean a shift from viewing products as cultural objects to greater emphasis on functionality (5).

Focusing on sustainable development will mean identifying new ways of meeting needs more effectively and directly - which will mean more and better two-way communication with customers. However, many companies have forgotten to talk to customers and have focused inwardly on the technological and engineering improvements required for, primarily, eco-design e.g. using less energy, using less components, using less packaging, etc. The Kambrook kettle is a good example. There was considerable attention to making the product more energy efficient, but the breakthrough came when a dialogue was created with customers which generated increased understanding of customer behaviour. Market research amongst users gave a new perspective, which led to the development of a greener solution (6). Husqvarna AB's solar-powered lawn mower is a different type of example. From a sustainability viewpoint, it is not *the* sustainable solution to cutting grass, but it demonstrates that more sustainable ideas can reach the marketplace if the conditions are right (7). Such slightly 'off the wall' concepts create discussion, and make at least some people think about new solutions and the inherent complexities! People must have examples, that catch their imagination. If you cannot *see* it, you cannot *do* anything about it!

The process of product development starts with an idea and grows into a concept. Therefore if those individuals whose responsibility it is to generate and manage the creation of new products have no awareness and understanding of the concept of sustainability, then we will only get random and incremental advances, not stepwise changes for 'Factor X' or sustainable (e3s) solutions. The pressure to reduce 'time to market' and perceived costs are key constraints to eco-design or more broadly SPDD. Environmental information should focus on the needs of the stakeholders in the process. However, the data is often seen as complex and time-consuming and likely to slow down the product development process. To enable the effective implementation of eco-design or SPDD information will have to be packaged more effectively. There should also be wider stakeholder input into the process, with sustainability thinking injected as early as possible, particularly from customers and suppliers. Considering the issues at the design stages is too late, as many decisions will have been made and opportunities missed. SPDD is a much broader agenda and requires innovation across all e3s issues (environmental, economic, ethical, social). This means not just developing innovative new products, but innovative and new ways of using and re-using products i.e. shifting 'products to services' or dematerialisation. SPDD will mean developing new processes to deliver those products and services whilst working and co-operating with internal and external stakeholders much more closely. Ultimately, SPDD should be about improving the 'quality of life' for customers, employees and other key stakeholders.

Needs

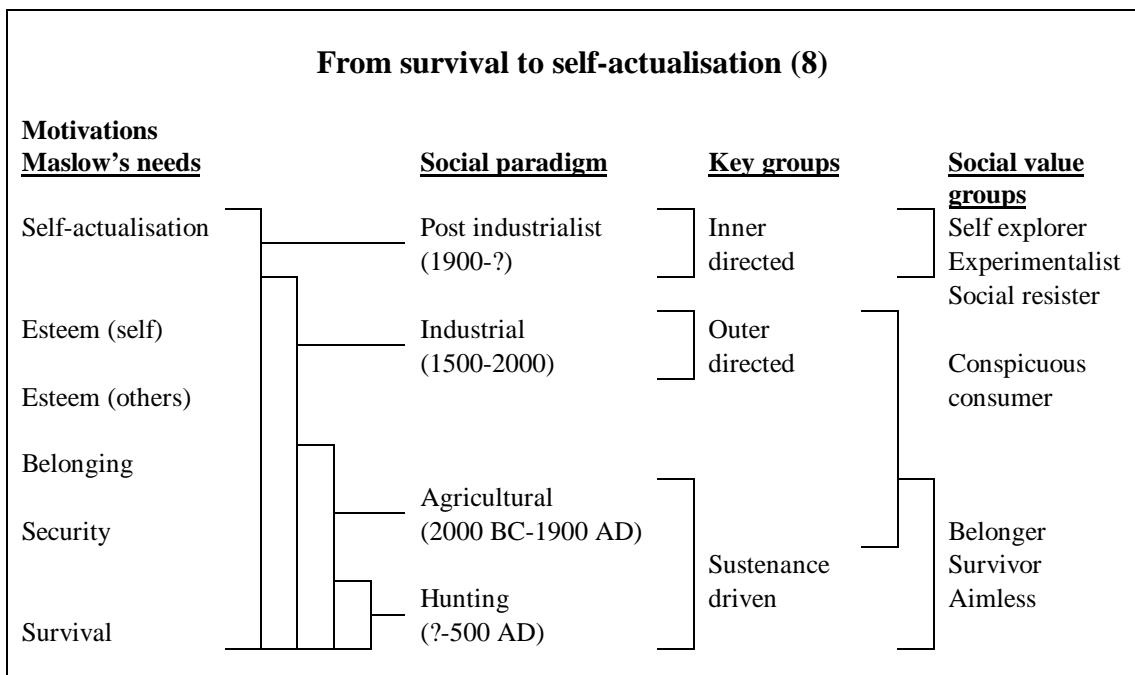
Central to the sustainability agenda is the issue of satisfying human needs, in the short, medium and long-term. With a growing world population there will be increasing pressure on both renewable and non-renewable resources, with a key element of the equation being the strategic shift in the powerbase from North to East and South, coupled with the increasing speed of information flows, accelerated by the rapid development of telecommunications. This will mean more choice, more competition and more change.

The lawn-mower

Maslow developed a ‘hierarchy of needs’ which illustrated a series of levels, that could only be attained when the previous level had been satisfied, starting at physiological (shelter, housing, etc.) and ending at self-actualisation (essentially, developing oneself to your fullest potential).

Maslow’s hierarchy of needs (8)	
Needs	Description
• physiological	air, food, water, sleep, sex
• safety	security, comfort
• belongingness	love, acceptance
• esteem	recognition, approval, achievement
• cognitive	to know, understand and explore
• aesthetic	beauty, symmetry, inter-relationship
• self-actualisation	meta needs, derived from integration of all needs

From a Northern perspective much of the discussion over eco-design and SPDD relates to self-actualisation. However, from a Southern perspective, SPDD relates to basic needs e.g. food to live and ‘design for necessity’ e.g. shoes from car tyres or palm leaves. However, there are shifts happening in the North where some are ‘downshifting’ and asking themselves ‘do we really need it?’. These ‘downshifeters’ are starting to decouple ‘quality of life’ from material consumption. The lawn mower is an interesting example. ‘Green consumers’ in suburbs may shift from using solar-powered lawn mowers with no human intervention to being rural or semi-rural sustainable consumers using mechanical lawn mowers that cut the grass and keep you fit!



The fridge

The fridge was developed as a technological response to the human need to preserve food e.g. to fulfill physiological needs, however in modern society it now also satisfies a series of less essential secondary needs.

- heating room (if inefficient)
- looks aesthetically pleasing
- preserves non-food items e.g. medicine/film
- fills a space
- can put flowers on it!

However, if we explore deeper and look at lifestyles, a fridge enables consumers to shop less frequently and potentially reduce food waste. The need for a fridge depends on lifestyle patterns i.e. diet, number in household, proximity of food distribution and climate. Clearly, the fridge has a range of environmental impacts with the prime issue being energy use, particularly in the 'use' phase, with existing greener solutions focusing on energy efficiency and elimination of chlorofluorocarbons (CFCs). There are existing substitutes and compliments to the fridge including traditional preservation means e.g. tins, jars, larders and cellars, each with their own environmental impact - but these are often forgotten. Should we be moving towards 'just-in-time' food purchasing, buying and using locally manufactured 1st, 2nd, 3rd life fridges, consuming locally produced food. Micro-responses to fridge including individually cooled drinks, and DIY fridges are unlikely to have considered 'green' issues in the development of these solutions.

However, a growing problem is the aspirational demand in developing countries for fridges to enable consumers to preserve and store modern food, where they could be using traditional means or developing solar-powered solutions. Looking from a systemic perspective, one should be exploring the development of systems for re-use of waste as raw materials (food) emerging out of the concept of industrial ecology. For example, a brewery linked to a fish farm and greenhouses - where the organic waste from the brewery is used as food for fish, and excess carbon dioxide (CO₂) is used to grow fruit and vegetables using hydroponics.

If we explore the solution from a different perspective:

a fridge is a technology that provides an 'environment' - at a controlled temperature - to enable food to last longer.

How do we make a more sustainable solution to the fridge whilst reducing impact and increasing value?

Consumption and production

Chapter 4 of Agenda 21 - the blueprint for sustainable development - published in 1992 at The Earth Summit covers "Changing patterns of consumption". It highlighted that present consumption levels are causing serious environmental problems. However, consumption drives the creation of income and export markets needed to promote worldwide prosperity. What is needed is a re-focusing of consumption patterns based on efficiency, equity and concern for the future. The replication of present consumption patterns by developing countries is not a viable solution to the sustainability conundrum. However, levels of consumption must be increased to

improve overall 'quality of life'. Therefore strategies for eco-efficiency and waste minimisation will be essential (9).

The Rio + 5 Conference in New York in June 1997, reinforced the growing need to develop more sustainable patterns of consumption and production (10). One of the outputs was an initiative on eco-efficiency with a target of achieving a tenfold improvement in productivity in the long term, with a possible fourfold increase in the next two or three decades amongst industrialised countries. Governments also agreed to promote measures to internalise environmental costs and benefits in the price of goods and services, and to consider shifting the burden of taxation onto unsustainable patterns, through, for example, reducing and eliminating subsidies to environmentally harmful activities.

Sustainable Consumption

"The challenge today remains the same: to meet an enormous projected global demand for resources, especially energy, through the use of new products, technologies and consumption patterns which will provide rising standards of living for all, while minimising economic costs and risks to human health and the environment" (11)

The role of products and services in this process is central to this debate. Addressing this discussion will mean asking fundamental questions such as what is a sustainable product?, how does one develop and design sustainable products? and how does SPDD differ from eco-design? It means thinking through complex issues such as meeting the basic needs of the world's poor and reducing global inequalities. A major challenge is how to infuse sustainability issues at the 'front of the pipe', where new ideas and concepts are generated and issues are poorly understood.

The role of technology

"Technologies enable humans to expand their range of activities and transform the earth's resources, thereby delivering equivalent or improved services while greatly reducing health and environmental burdens. Two long-term trends offer particular hope for mitigation of these adverse impacts: improvements in energy and materials efficiency and decarbonisation* of energy sources" (11)

* decarbonisation: the decreasing ratio of carbon emissions per unit of primary energy (and a shift to cleaner energy).

Social behaviour patterns and technological development can change rapidly and they represent powerful agents of change and a potential area of optimism.

Domestic consumers

Most discussion over sustainable consumption still revolves around environmentally-considered consumption or 'green' consumerism; ignoring ethical and social aspects.

Ethical trading is often seen as distinct from green consumerism with the connection and relationship between all four e3s issues often ignored. The general public are fickle in relation to 'green' purchasing, with surveys indicating an 'Action-Awareness' gap i.e. growing interest in the environment but a lack of transference to buying 'green' products at the checkout, with economics (price) still being a key purchasing criterion.

Green consumers

“... the citizens as consumers tend to act so as to maximise the amount they can buy for their money - environmental options have to give their best return/value to the consumer. You cannot simply rely on the altruism of the green consumer” (12).

There is a clear lack of consistency in 'green' consumer behaviour, for example choosing a 5 litre BMW from the car-pool, but using phosphate - free washing-up liquid and driving 10 miles to recycle two wine bottles!

Research in the UK (12) has indicated that consumers are interested in becoming greener, but there are three key obstacles:

- consumers' poor understanding of environmental issues - with effort often put into activities which have little effect
- confusing, unfocused and sometimes misleading information from business and regulators
- a feeling that government and industry is not doing enough to give consumers 'green' options

Environment versus economy		
	1997	Change since 1996
Protect environment even at the expense of economic growth	13%	+2
Try to have a balance, but the environment is more important	57%	+8
Try to have a balance, but economic growth is more important	2%	-3
Promote economic growth even at the expense of the environment	2%	-3
Source: “1997 Green Guage Report”, a publication of Roger Starch Worldwide (RSW)		

Recent research in the US by Roger Starch Worldwide (RSW) has indicated:

- concern over air pollution is at its highest level since 1989 (when RSW studies started)
- the public is more likely to regularly take part in environmental behaviour (1997 compared to 1996)

- consumers are willing to pay the largest premium for greener goods since before the recession.

The Five Market Segments								
Segment	'90	'91	'92	'93	'94	'95	'96	'97
<i>True-Blue Greens</i> Most environmentally active society	11%	19%	14%	14%	11%	11%	10%	12%
<i>Greenback Greens</i> Willing to pay highest premium for green products	11	6	5	6	4	7	5	6
<i>Sprouts</i> Have embraced environmentalism more slowly	26	32	36	35	33	31	33	37
<i>Grouzers</i> Use excuses to rationalise lax behaviour	24	17	11	13	13	14	15	13
<i>Basic Browns</i> Environmentalism is simply not a priority	28	26	33	32	37	35	37	29
Source: "1997 Green Guage Report", a publication of Roger Starch Worldwide.								

However, the existence of ethical consumer - buying or boycotting based on e3 factors - has been well documented and there has been a range of research undertaken into the socially responsible consumer, with the 'green' consumer always only being the top of the iceberg.

Attitude change

"Not only do more environmentally responsible products need to be more competitive, but there is a need to change consumer attitudes so that, for example, more people value and pay a premium for longer life products" (13).

Intermediate consumers

Husquavna's experience resulting from the development of the solar powered lawn-mower indicated that distributors displayed a considerable degree of scepticism about eco-innovation. Retailers, wholesalers and dealers will not buy new products unless they first *see* a market. There is a need for a systematic education and training programme for sales people within retailers and wholesalers to increase awareness and understanding of environmental and broader sustainability issues, to enable them to communicate 'green' features and benefits more effectively.

'Business to Business' consumers

There will be increasing pressure for eco-designed products particularly driven by ISO 14001 requirements to increase understanding of the direct and indirect environmental

impacts of products and services. The extent to which broader social and ethical issues are expanded out into the supply chain - will be dependent on senior level vision and commitment. For example, Body Shop International employ ethical audits throughout the supply chain which are driven from the CEO, Anita Roddick. Corporate social responsibility and a 'licence to operate' may pressurise companies into taking a broader stance, particularly emphasised by the potential of the Internet to expose transgressions, globally, more often and more quickly.

Sustainability: key issues

A multitude of definitions of sustainable development exist with the majority exploring the concept from an environmental perspective, with less emphasis on social and ethical considerations.

Education

There is a general lack of awareness and understanding of sustainability with the concept often applied to the maintenance of economic longevity i.e. sustainable economic growth. If more sustainable products or services are going to be developed and designed, then there needs to be more understanding about of the practicalities of the concept and the underlying issues. Therefore if we are discussing SPDD, a key issue is infusing the understanding of sustainability into the earliest stages of product development. This process may highlight far-reaching opportunities such as fundamental shifts from offering products to providing services. These shifts will require strategic level decision-making within business, and possibly a re-definition of business in terms of delivering increased value through high quality *stakeholder service*. Education and re-education will be needed amongst all stakeholders to re-orientate the product development process towards sustainable solutions.

Stakeholders

There is a need to change mindsets within each stakeholder group, with a key question being do stakeholders feel a stake and, or engagement in the sustainability discussion. If not, the question is why not? There is a need to work on peer pressures within and between stakeholders e.g within transnationals through the World Business Council for Sustainable Development (WBCSD) and down through the global supply chain. The potential for change through the supply chain is significant as major multinationals source raw materials, sub-assemblies and components globally - therefore the impact will not necessarily be at the point of decision, point of manufacturing or *service delivery*, but could be anywhere in the world!

Economic structures

Existing economic structures don't take account of wider environmental, ethical and social factors and there is a need for more holistic costing mechanisms, which will require a change in economists and accountant's mindsets and language. There is a need to develop at a minimum environmental accounting and at an optimum sustainability accounting. An opportunity might be to develop temporary eco-taxes on products or services, as flags to reduce or change consumption towards more positive products. There is a clear need to reward and incentivise successful behaviour e.g. subsidies or 'tax breaks' to develop solar technologies, and penalise and disincentivise impactful action e.g. carbon taxes to reduce carbon dioxide (CO₂) emissions.

Partnerships

To move towards sustainability will mean the development of stakeholder partnerships - particularly with customers and suppliers. A key issue will become the management of the 'sustainability web' - the network of environmental, economic, ethical and social (e3s) impacts related to products and services, and their suppliers. A possible strategy could be to shift 'sustainability ownership' forwards or backwards dependent on the supplier's position in the 'value chain'. This may be highly complex or relatively simple. Electronics manufacturers have highly dispersed and complex 'value chains' due to their web of material, component and sub-assemblies suppliers. However, suppliers of commodities have a simpler 'value chains'. For example, how do stakeholders in the coffee 'value chain' minimise the 'sustainability impact' from growing through processing to distribution and consumption? Sustainable solutions may require partnerships with formalised contracts and high levels communication e.g. meetings, e-mail, etc. For example Body Shop International have a partnership agreement with the Lane Group - a logistics company - with agreed economic and environmental objectives and commitments. In addition, Body Shop International have found that the use of ethical audits amongst suppliers has improved communication and created better business relationships. A key issue is how much power and influence can stakeholders have over each element the process. Can commitment to sustainability be infused throughout the full 'value chain' if the motivation is strong enough. The success will require collaboration with vision and strong leadership.

Leadership

There is lack of vision about sustainability amongst key stakeholders, with a clear need to move from research and debate towards intelligent action to find and develop sustainable solutions. Clearly, sustainability is a global, national and local political issue. For example, the Kyoto conference on climate change in December 1997, illustrated the power of individual countries and industry sectors to influence the agenda.

Eco-innovation: E-tech

In 1996, Husquavna R & D Laboratory made a breakthrough in the development the *E-tech* two-stroke engine, with a technology that significantly reduces exhaust gases and particulates, needed 40% less fuel and produced 40% more power than previous products. Previous catalytic converters had added 300 grams to the weight of the engine, whereas the new technology added 10-20 grams with a better power-to-weight ratio, reduced need for maintenance, lower cost and lower exhaust temperature. To reduce the 'time to market', development was completed concurrently with suppliers and tool manufacturers being an integral part of the team from an early stage. Taking the technology to market took only 8 months instead of the normal 18-36 months!.....

"Every member of our team - about 50 people - wanted the project to be a success. They wanted to show the world that it was possible to develop an affordable, lightweight, two stroke engine that had minimal environmental impact."

Bo Andreasson, Vice President, R&D, Husquavna, Sweden

Source: Electrolux Environmental Report 1996

Retaining 'value'

Underlying both new and existing product development and design is the need to minimise e3s impacts throughout the life cycle. This means incorporating SPDD principles into processes, now; and in parallel, developing structures and systems to extend the life of the millions of products that come to the end of their first life, every day. An economic infrastructure needs to be created by government to collect and keep existing 'sustainable (e3s) value' in the economy through upgrading, dismantling, reverse logistics, remanufacturing, reconditioning, recycling and other strategies. This will enable resources to be retained in 'the cycle', as well as creating employment opportunities at the 'end of life' and through all points of reverse distribution, as well, as in 2nd, 3rd, 4th life product development. Therefore it means managing both 'front of pipe' and 'end of pipe', and the processes between and not either. This will require a more holistic form of environmental or sustainable business management.

However, today there is still significant inertia in the system. If your kettle stops functioning there is generally no clear collection mechanism to intervene to prevent 'the product' going to landfill i.e. a radio may have cost you £20 and repair may cost you £60, and you may have to travel 20km to locate the repairer! (14). That is why 'end of life' electronic products pile-up in the office cupboards and in the home - based on the thought process "it doesn't work, I can't repair it, but I still perceive it has 'value', therefore I will not throw it away!".

This phenomenon is important from both an economic and psychological viewpoint. There is a need to keep the 'value' of physical goods in 'the cycle' if we are to move towards 'Factor X' levels of resource and energy reduction i.e. why generate new energy or extract new virgin materials if we can retain and extend existing products or services. Antiques are a good example of the link between 'economic value' and 'psychological value'. Where there is a perceived 'value' of an artifact, it generates an 'economic value' related to the basic economics of supply and demand i.e. as more people want the scarce artifact, the price goes up!. Within the sustainability context, there is a need to generate a concept of 'real value' or deeper 'sustainable (e3s) value' of products or services amongst customers.

Creativity and Innovation

Business has primarily seen sustainability as a threat rather than a series of opportunities and there is a clear need for perspectives and tools to enable stakeholders to *see* the opportunities. This *seeing* is unlikely to just come through systematic market analysis, there will need to be a more creative or imaginative visions. Therefore a 'sustainability screen' should be incorporated into the new product development process. When ideas are generated and concepts developed, there should be some positive stimulus towards thinking about more sustainable products or services.

The ideas and concepts that produce reduced 'sustainable (e3s) impact' and, or maximise 'sustainable (e3s) value' must be recognised and developed, and this requires more education, awareness, and increased creativity amongst all stakeholders in the process. Sustainable products and services must be assessed against all e3s criteria including straight forward business criteria (e1) e.g. profitability, reduced eco-impact (e2), the ability to generate social (s) and ethical (e3) value e.g. to create employment

and create 'good' employment throughout the 'value chain'. What should be considered is the ability to produce reduced 'sustainable (e3s) impact' or increase 'sustainable (e3s) value' overall i.e. to move towards more sustainable *service* solutions. A key issue to be addressed is that you cannot have a sustainable product or service in an unsustainable system (5), but a company, economy or world can move towards a more sustainable situation - if the overall impact generated is greater than the sum of the parts (2+2=5) - 'sustainable product synergy'.

Accelerating innovation

Technological efficiency is constantly improving, but innovation, and wider deployment, must be speeded up in order to have a serious impact on global levels of productivity and pollution - efficiency gains so far this century have been more than offset by the volume of economic growth. Reversing degradation of natural resources will take decades and delaying necessary reforms will greatly increase the monetary and human costs involved.

The goal of sustainable development should serve, in practice, as a wake-up call: to share and make maximum use of capabilities we already possess (11).

Beyond eco-innovation

'Factor X' levels of reduction in energy and materials consumption will not come about through incremental change, but will require radical new solutions. Eco-innovation focuses on e1e2 issues but neglects social and ethical issues - its use will produce new solutions but not the breakthroughs needed to move towards sustainability.

Eco-innovation: 99% reduction in materials

Dow Elanco worked with pest controllers to reconfigure delivery services. It succeeded in reducing the amount of material needed to provide termite protection by 99% (1).

In addition, moving beyond eco-innovation to 'sustainable (e3s) innovation' will require the creation of new *processes* to produce new products and services that provide customers with more real 'sustainable (e3s) value' and significantly reduced 'sustainable (e3s) impact'. This will necessitate a new corporate framework to manage product and service innovation. The more significant the change required the more strategic the decisions will need to be, and the closer to the 'front of pipe'. However, at present, most changes are at an operational level i.e. incremental eco-design changes to existing products. Within the sustainability context, innovation cannot just create new substitute markets unless they create more 'sustainable (e3s) value' and reduce 'sustainable (e3s) impact'.

Electrolux: three levels of eco-innovation

- | | |
|--------------------------|--|
| • continuous improvement | e.g. improved energy efficiency in refrigerators |
| • technology adjustment | e.g. catalytic convertors added to chainsaws |
| • new concepts | e.g. solar-powered lawn mower |

It is important to recognise that one cannot move the course of a super-tanker ship in a second. Customer (domestic, intermediate, 'business to business') acceptance of eco-innovations (e1e2) is the first step towards radical e3s change e.g. the solar-powered lawn mower. However this is not the radical mindset and infrastructure change required to move towards sustainability. Therefore we must ask ourselves what is ethical innovation? and what is social innovation?

e3s innovation model

e3s issues	Innovation	Process	Product
e1		technological financial	technological financial
e2		waste minimisation cleaner manufacturing	new concepts re-design eco-efficiency less materials less energy
e3		fair trade equitable policies	cruelty-free cleaner materials
s		'good' employment investment in communities	satisfy real needs more customer 'value' better systems

Notes:

- Process is defined as the process of delivering *service* (1st, 2nd, 3rd life, etc.) to the customer (consumer, intermediate, 'business to business').
- Product is defined as the delivered *service*.

Radical changes in product and service development will necessitate changes in *process management* notably in manufacturing, procurement and materials management. This will mean the need for changes in product development and design policies, coupled with changes in customer perception and behaviour. This will only be achieved as a result of improved communication, education and re-education.

For example, moving towards car sharing implies that the *product* will be *owned* by consumers paying per unit of *service* i.e. mileage and time. There will need to be a shift in consumer behaviour from 'individual consumption' (outright purchase of cars) to 'organised consumption' (rental of cars). Such a shift will produce less traffic congestion, reduced emissions, and therefore less air pollution, but will mean that fewer cars will be needed (15). A more intensified use of fewer products e.g. cars, will produce significant implications for product design, technology, costing 'end of life' management and will create employment shifts. To enable a movement from products

to services, there will need to be more systemic planning and management, an ethos of continuous improvement and ongoing societal programmes of stakeholder education.

The relationship of SPDD to Industrial Ecology (IE)

(INSERT DIAGRAM)

IE is a methodology for understanding environmental sustainability, but with no clear reference to social and ethical dimensions. Essentially, eco-design or DfE ('Design for Environment') is the operationalisation of IE at the level of the product with a focus on e1e2. IE recognises the wider system, and the holistic relationships involved in materials and energy flows, but does not address issues such as satisfaction of basic needs, social equity, poverty, employment and health and safety issues. What is needed is another macro-model, where SPDD becomes the operational tool within the sustainability context. Is *that* model sustainability, or beyond sustainability as presently defined?

Sustainability company, sustainable product

When the business is viewed as part of a wider ecological system, it starts to provide a deeper insight into inter-relationship with the wider environment and society.

(INSERT WILKHAHN DIAGRAM)

The World Resources Institute have developed the Sustainable Enterprise System (SES). The concept highlights a series of economic agents in the 'sustainability web', who act independently or together, to fulfill a market demand while contributing 'net value' to society, the environment and shareholders.

(INSERT SES DIAGRAM)

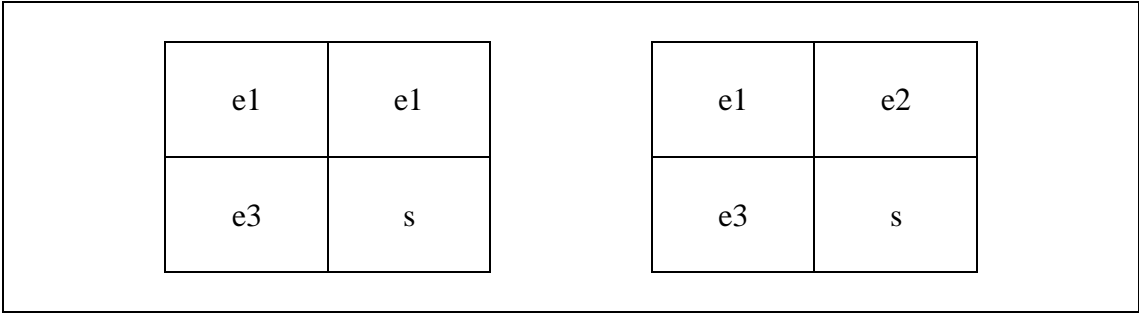
Seen from the perspective of the company, *services of society* can be broken down into labour (the 'internal' aspect of society), social (the 'external'), and nature which supplies the 'fuel' e.g. resources and energy for the enterprise engine. Labour services supply innovation and work, and social services provide a market, culture and infrastructure. SESs must preserve, and ultimately enhance the value of natural, labour and social services.

There will be a need for a different perspective and the need to look through a new window. The ability of companies to perceive and then to shift direction to take advantage of new opportunities and adapt to or avoid threats, will be of growing importance. Therefore inevitably the discussion leads us into the viewpoint of the delivery of more sustainable products and services, from more sustainable companies.

e3s fractal: sustainable company, sustainable product

COMPANY (e3S)

PRODUCT (e3S)



Sustainable products and services might display some or all of eight characteristics below.

Eight characteristics of sustainable companies and sustainable products.	
<ul style="list-style-type: none"> • Innovative • Flexible • Partnership • Zero waste 	<ul style="list-style-type: none"> • Cyclical • Entrepreneurial • Learning • Intelligent

Integration

To move towards corporate models of sustainability and mechanisms that ‘filter-down’ to product development, a major challenge will be the integration of existing business concepts e.g. social responsibility, total quality management (TQM), community relations, ethics, health and safety and environmental issues, producer responsibility and product stewardship. At present these issues are usually separate - although one has often seen corporate environmental concern emerge out of quality and, or health and safety functions. ‘Producer responsibility’ is being driven through in both the automotive and electronics sectors as a result of impending European legislation and will become a key driver for eco-design, particularly strategies for ‘design for reverse logistics’ and ‘design for dismantling’. This will mean increasing pressures to manage products at the ‘end of life’, but also an increasing focus on reducing product-related environmental impacts through the lifecycle, particularly at the design stage. However, operationalisation of business sustainability is in its early stages, with a lack of integrated models, outside of ‘green’ niche companies. The reality is that sustainability has become a substitute word for environmental management - with a lack of deeper thinking. Therefore tools are virtually non-existent.

Measuring SPDD

But, how does one measure the relative sustainability of the product? Sustainability metrics do not exist at a company or product level. Measures of financial performance (e1) are well understood and environmental (e2) metrics are starting to emerge at both corporate and eco-design level. Focusing on the need for quantifiable objectives has led to the development of eco-design metrics (16), however this does not help with the ‘softer’ issues. Broader sustainability indicators are primarily being explored on national government and local authority level particularly in relation to Agenda 21 and Local

Agenda 21 but have not percolated down to the level of the company or the product or service.

At a macro-level an interesting framework has recently been produced which have broader implications for SPDD. The Bellagio Principles were established in November 1996 to deal with the four aspects of assessing progress toward sustainable development. Principles 1 highlights *starting-point* - the need to establish a vision of sustainable development and clear goals that provide a practical definition of the vision. Principle 2 through 5 deal with *content* of any assessment and the need to merge a sense of the overall system with a practical focus on current priority issues. Principles 6 through 8 deal with key issues of the *process* of assessment, while Principles 9 and 10 deal with the necessity of establishing a *continuing capacity* for assessment.

Bellagio principles

1. Guiding vision and goals
2. Holistic perspective
3. Essential elements
4. Adequate scope
5. Practical focus
6. Openness
7. Effective communication
8. Broad participation
9. Ongoing assessment
10. Institutional capacity

Social and ethical metrics are virtually non-existent. Apart from e1 issues such as profitability, cost, risk, customer loyalty and market share, one should start to explore alternative metrics. For example, social (s) metrics might include total new employment generated in the value chain, new knowledge created, or contribution to society. A sustainability index for products/services should be developed - based on relative impact of balancing both negative and positive sustainability (e3s) impacts and value.

e3s	metric	key stakeholders
e1	financial (£)	shareholders senior management
e2	waste (volume) energy (volume: £) financial (£)	legislators customers communities
e3	awareness (%) attitudes (%)	employees customers
s	awareness (%) attitudes (%) employment (volume)	employees communities

In addition, if we focus on what is unacceptable performance for a product or service and then reverse it, this will start to give us a clue as to what improved SPDD performance might mean.

SPDD Performance

Unacceptable

- expensive (e1)
- highly polluting in manufacture
- (e2, e3, s)
- highly wasteful in manufacture
- (e2, e3, s)
- uses toxic materials (e2, e3, s)
- using child labour (e3, s)

Acceptable

- fair(er) price
- clean(er) manufacturing
- more eco-efficient
- clean(er) materials
- fair(er) employment policies

The above illustrates the integrated nature of the problem and the issue of *values*. From the moral high ground using child labour is unethical, but if the children are generating income for the family to live, then is it unethical not to employ them?

A key issue is who decides what is good e3s performance - particularly when looking at 'softer' social and ethical issues!

The analysis is also inextricably tied to international trade and consumer issues. The use of boycotts or negative screening by environmental groups can affect both developed and developing economies. For example, recently Norwegian products have been boycotted, as a result of the country's pro-whaling policies and previously many South African products were not purchased because of the previous government's apartheid policy.

Sustainable Product Design: principles and criteria

Principles:

- waste equals food
- use current solar income
- respect diversity

Criteria:

- cost (can I afford it?)
- performance (does it work?)
- aesthetics (do I like it?)
- is it ecologically intelligent (do its materials comply with the principles?)
- is it just (is everything equitably considered?)
- is it fun (do I get up in the morning and want to do it?)

Source: Professor William McDonagh (15)

Service Product Development and Design

Many of the social and ethical issues surrounding SPDD are as applicable to complex organisations with complex products i.e. transnationals assembling vehicles for space travel - as to simple organisations with simple products i.e. co-operatives growing organic coffee in Kenya. These issues are applicable to corporate thinking irrespective of the complexity of the tasks undertaken or whether they produce products or services. For example, there are a range of sustainability issues involved in the growing of coffee e.g. fair wages, working conditions, and water pollution.

Coffee

SPDD does not only relate to *tangible* products - it should be considered in *service product development*. The coffee shop in an airport has various elements that make up *the service*: the coffee itself, cups, brewing, storage, etc. Then 'what if' the coffee is consumed and the cups are disposed of in bins in the forecourt - are they recycled? Clearly there are social and ethical, as well as more obviously environmental impacts to *the service*. For example, Starbucks Coffee in the US highlights its wider ethical and social consideration on its paper cups:

“Caring for those who grow our coffee - Healthy beginnings in Indonesia: with our support CARE has provided over 35,000 women and their infants with access to health services, immunization and nutrition education in southern Indonesia. Please join Starbucks in support of CARE by calling 1-800 521-CARE”.

The prime focus of Starbucks' environmental improvement is on eco-design. The coffee is served very hot which means using two cups which produces significant waste. To work on the problem of product re-design and waste minimisation, Starbucks has created a partnership with the Alliance for Environmental Innovation (6).

From an SPDD viewpoint, a broader question might be: if Starbucks are committed to moving towards sustainability should they be working on fair trade issues with suppliers in Indonesia?

Telecommunications

Dematerialisation can generate 'Factor X' levels of energy and material reduction. For example, moving from producing paper-based books, to electronic books on diskette or CD-ROM, to shifting to information downloadable via Internet or Intranet - eliminates the environmental impacts associated with transport, packaging and stock - through a move to 'just-in-time' publishing. However, there are major customer behaviour issues associated with such changes e.g. many people don't like reading from the screen and many like the aesthetics of the book (19). Technology is essentially neutral to sustainable development - it is about how people will apply it!

Services delivered via telecommunications can produce benefits across the sustainability (e3s) agenda. Digital Equipment Corporation (DEC) in the UK have operated a flexible working scheme which gives employees the opportunity to work

from home or office. Each person can receive faxes, e-mail and voicemail via an integrated mailbox from anywhere in the UK through a portable modem.

Environmental benefits

- less office space required
- reduction of community travel

Social benefits

- Employees have choice and flexibility to work where they want

Economic benefits

- Savings of £3500 per person per year
- An increase of productivity of 20-30% per worker (20)

The responsible product developer and designer should take account of the long-term conditions that will enable a more sustainable system to develop. The aim should be to develop and design exemplary, best practice products and products that minimise unsustainable impacts across e3s criteria. But he or she cannot act in isolation. Developers and designers should be employing sustainable (e3s) lifecycle issues analysis to identify the critical issues and be forming cross industry partnerships to create solutions to minimise the ‘sustainability (e3s) impact’ throughout the lifecycle!

Sustainable (e3s) lifecycle issues analysis

e3s	e1	e2	e3	s
Phases				
Pre-production				
Production				
Transportation				
Use				
Disposal				

Marketing

The involvement of the marketing function is essential to progressing SPDD. However, it is particularly complex as the role and function of marketing differs by organisation, corporate culture and market. Outside niche ‘green’ companies, understanding of environmental and sustainability issues amongst the marketing function is poorly developed. In addition, several surveys have indicated a weak organisational relationship between the environmental management and marketing functions. However, some organisations have started to educate marketing personnel about eco-issues e.g. Philips and Nortel.

(INSERT TABLES)

To enable marketing to move towards an understanding of sustainability will require new models. For example,

- Re-consumption: the ability to use and reuse goods in whole or in part, over several use-cycles or generations

- Re-direction: re-focus customers needs and wants towards consumption that is environmentally less harmful
- Re-orientation: changing all elements of the marketing mix from product, to packaging to printing and communications
- Re-organisation: a vision and commitment towards a more sustainable future must be translated into strategies and action plans. This may mean restructuring and redesigning many of the processes and systems in the company (21).

Design

Eco-design has essentially been *owned* by the environmental management function and has not been integrated into mainstream product development and design. Designers are potentially key players in the process but have generally low awareness and understanding of environmental and broader sustainability issues.

(INSERT TABLES)

As yet, design has not been actively involved in this debate. In fact, it has often been seen as part of the problem. However, in trying to address the sustainability issue, product design appears to be going through a ‘crisis of consciousness’ and asking itself a range of questions e.g. what is the role of design in debate? what are the opportunities to offer ‘value-added’ services? should we have confidence to go beyond the ‘client brief’? A critical issue is to examine what we mean by design in the context of the creation and development of products and services. It is also essential to separate out the education and information needs of the different design disciplines. For example, design engineers are: concerned with the function and composition of products; comfortable with quantitative issues; uncomfortable with qualitative issues. Whereas the industrial designers are concerned with aesthetics: comfortable with qualitative issue; uncomfortable with quantitative issues. The mix of design will change dependent on the product/market situation. What designers need is usable tools. But as yet, these have not been forthcoming.

SPDD tools

At a minimum if we are to achieve ‘Factor X’ levels of resource and energy reduction there is a need for a new set of tools. However, ‘Factor X’ only addresses e1e2 issues and ignores the ethical (e3) and social (s) dimensions of the equation.

“I’m educated to death, but I can’t implement anything.” - Anonymous

As the broader agenda is so new in business, virtually all educative and analytical tools have focused on understanding and evaluating environmental impacts.

Characteristics of different valuation for eco-sustainability

Concept	unit	flow
LCA	m ²	output
DfE	?	?
Eco-m	?	?
MIPS	kg	input
SPI	m ²	input, output

ACC	m ²	input
WPE	kg	output
PCC	EURO	output

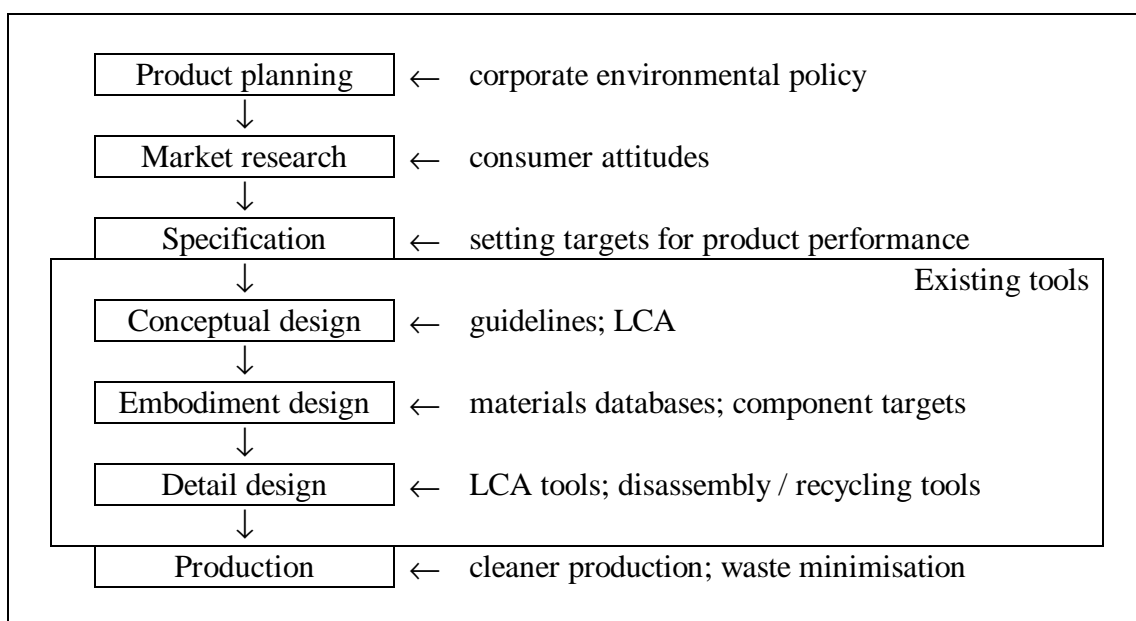
Source: 'Managing eco-design: a training solution', Charter, The Centre for Sustainable Design, 1997.
 Adapted from: 'Quantifying the interaction of human and ecosphere: SPI as measure for co-existence'

Key:

- LCA = lifecycle assessment
- DfE = 'design for environment' or eco-design
- Ecom = eco-compass
- MIPS = material intensity per unit-service
- SPI = sustainable process index
- ACC = appropriated carrying capacity
- WPE = waste potential entropy
- PCC = pollution control costs

The most well recognised tool covers e1e2 issues- lifecycle assessment (LCA). Leading-edge companies are starting to explore the use of 'cut-down', simplified LCA's due to the dual pressures of growing environmental awareness and need to reduce 'time to market'. However, there is a need for a usable toolbox to deal with the different requirements of those involved in the product development process, and the different stages of the product life cycle, taking account of full e3s impacts. Conventional tools cannot do this.

Stages of the engineering design process and existing eco-design issues, methods and tools



Source: Adapted from 'Integration of DfE tools with product development'
Pogner, J., and Simon, M. 1995

More sustainable product and service ideas and concepts must be recognised and developed, and this will require more awareness, education, and increased creativity. Sustainable products and services should be assessed against all e3s issues including straight forward business criteria (e1), the ability to generate social (s) and ethical (e3) development through the creation of 'good' employment throughout the 'value i.e. the ability to deliver a reduced 'sustainability impact' throughout the 'value chain' and, or to create more positive 'sustainability value'.

Product development stages: existing tools

Idea generation

- eco-compass (Fussler with James)
- eco-innovation process (Charter)
- sustainability wheel (James)
- visioning (Stevels)

Concept review

- lifecycle analysis software [LCA] (various)
- eco-compass (Fussler with James)
- checklists (various)
- 'design for environment' / eco-design software (various)

Market assessment ?

Development ?

Launch ?

Product management

- eco-design metrics (Fiksel)

The majority of tools - both at macro and micro level - have been developed to focus on the e1e2 agenda. However, new tools are emerging to explore broader sustainability issues e.g. visioning, 'sustainability circle' and 'sustainability screen'.

Visioning

This is a process of imagining the future. It also incorporates mechanisms such as 'backcasting' i.e. working backwards from the future to establish what needs to happen today to get the desired future scenario. One can generate various scenarios by changing sustainability criteria.

Sustainability circle

(INSERT SUSTAINABILITY CIRCLE)

Environmental product evaluation is always a 'trade-off' between simplicity and complexity. The 'Sustainability Circle' considers:

- Value
- Physical environmental impacts
- Product attributes
- Social impacts

Its use draws attention to key trends and issues with regard to both the environmental and social side of sustainability. It can complement more quantitative approaches such as the Eco-compass, MIPS and eco-points.

Sustainability screen

This model is a simple matrix, that aims to ease various stakeholders through SPDD issues. Its use is subjective and depends on judgement and weighting - but provides a starting point for further analysis. Decision-makers make decisions based on numbers,

with a key issue in SPDD being how you quantify the social and ethical impacts of products and services.

Sustainability Screen					
products	e3s	e1	e2	e3	s
A					
B					
C					
D					
E					

Key:

e1=economic

e2=environmental

e3=ethical

s=social

Ethical Management

“Those of us who manage companies have a responsibility to underline the importance of ethics to our enterprises. There can be no question of simply playing lip service to the idea. We must, in our actions as well as our words, show our customers, and, indeed, all our stakeholders what our company stands for and what are our values.”

Sir Iain Vallance, Chairman, BT (20)

An Agenda for Action

There is a need for an objective operational model of sustainable development that incorporates all e3s elements. Part of this process will be to develop a more holistic view and to manage the product development process more effectively to ensure sustainability is embedded. The role of designers as facilitators of creativity could become central once sustainability imprints itself more firmly in the corporate and design mindset. A key issue is how we move the agenda from a focus on sustainability based on economic (e1) and environmental (e2) issues to a focus on holistic

sustainability incorporating all four e3s issues. Design has an important role to play in producing more sustainable solutions to product and service problems, but first it must realise it! There is a need to gain senior management commitment and facilitate discussion between environmental, marketing and design management, as well as a broader range of internal and external stakeholders. In addition, there is a need to develop a broader understanding of the interaction between environmental and social systems, and look for 'closed-loop' opportunities to extend existing products and re-use waste - managing both 'front' and 'end of pipe' not either, or. A key issue will be educating and re-educating business-people and particularly marketeers about the opportunities arising from the sustainability agenda. If SPDD is to move from the 'think-tank' to 'real life' it will be essential to understand the organisational reality of the concept and generate business benefits both in relation to the development of products, services and 'hybrids' i.e. products extended through services. Clearly, product developers and designers need to have a basic eco-literacy before they will be able to generate greener solutions, however, sustainability requires a broader understanding, beyond environmental education. There are likely to be different levels of environmental awareness, expertise and learnt knowledge within different companies, industries and countries which will mean the need for flexible approaches. Designers will need to be clearer about the business and environmental benefits of new concepts, to enable them to effectively *sell* new products to both internal and external customers. To achieve balanced solutions to sustainability's complex and evolving agenda, managers, product developers and designers will need to develop the ability to 'think out of the (green) box'! Clearly it is not 'business as usual' and new structures, systems, skills and tools will have to be developed.

SPDD Checklist

- Does the company have a policy on sustainable development?
- To what extent has the company embraced:
 - Total Quality Management (TQM)
 - Corporate social responsibility
 - Corporate governance
 - Environment
 - Health and safety
 - Business ethics
 - Producer responsibility
- Has the company integrated these concepts?
- To what extent have these concepts been applied to products and services?
- Does the environmental policy have a concrete statement on product stewardship?
- What are the companies key e3s impacts? How does this relate to products/services?
- What are the key e3s impacts across the lifecycle of core products?
- What opportunities are there to embed or add more e3 value to products/services?

References

1. 'The sustainability cycle: a new tool for product development and design', Peter James, The Journal of Sustainable Product Design (JSPD), The Centre for Sustainable Design (CfSD), Farnham: UK, Issue 2, July 1997
2. 'Managing eco-design: a training solution', Martin Charter, CfSD, Farnham: UK, 1997
3. 'Factor Four: doubling wealth; halving resource consumption', E. Van Weizacher, A. Lovins and L. Lovins, Earthscan, London: UK, 1997
4. ?, Going for Green, Department for Environment, Manchester: UK, 1996
5. Interview with Dr. Braden Allenby, Martin Charter, JSPD, CfSD, Farnham: UK, Issue 2, July 1997
6. Mainstream appliance meeting eco-design, Andrew Sweatman, JSPD, CfSD, Farnham: UK, Issue 2, July 1997
7. Learning from the introduction of green products: two case studies from the gardening industry, JSPD, CfSD: UK, Issue 3: October 1997
8. 'Green Pages', John Elkington, Tom Burke and Julia Hailes, Routledge, London: UK, 1988
9. 'Agenda 21: The Earth Summit Strategy to Save Our Planet', United Nations, Document E. 92-38352, 1992
10. CSD Update, Secretariat of United Nations Commission on Sustainable Development, New York: US, Volume 4, Issue 1, September 1997
11. 'Energy and materials consumption', 'Critical Trends: global change and sustainable development', Department for Policy Co-ordination and Sustainable Development, United Nations, New York: US, 1997
12. Feedback from consultation, 'The Role of National Environmental Policy in Developing Sustainable Industry and Commerce', Journal of Institute of Environmental Management, IEM, Edinburgh: Scotland, Volume 4 Issue 4, July 1997
13. 'Consumers and the Environment: can consumers save the planet', National Consumer Council, London: UK, September 1997
14. Editorial, Martin Charter & Anne Chick, JSPD, CfSD, Farnham: UK, Issue 2, July 1997
15. Changing consumer needs by eco-efficient services: an empirical study on car sharing, Meijkamp, 'Towards Sustainable Product Design 2' conference, London: UK, July 1997
16. 'Design for Environment', Edited by Joseph Fiksel, McGraw Hill, US, 1996
17. Interview with Professor Williams McDonough, Martin Charter, JSPD, CfSD, Farnham: UK, Issue 3, October 1997
18. Interview with Ralph Earle III, Martin Charter, JSPD, CfSD, Farnham: UK, Issue 4, January 1998
19. 'Towards sustainable publishing', Dr Martin Woodhouse, Epsilon, Haslemere: UK, 1996 (freely downloadable via www.epsilon-ltd.co.uk)
20. 'A question of balance: a report on sustainable development and telecommunications', British Telecommunications plc, London, UK, 1997 (freely downloadable via www.bt.com/corpinfo/enviro/)
21. 'Ecological imperatives and role of marketing', Jagdish Sheth and Alul Parvakyov, in 'Environmental marketing', edited by Michael Polonsky and Alma Minto-Wimsatt, The Howarth Press, Binghamton: US, 1995