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## **Enabling Sustainable Development through sustainable consumption and production**

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**Abstract:** A key aspect of moving towards Sustainable Development is Sustainable Consumption and Production (SCP) and enabling us to meet our human needs in more sustainable ways. This is a complex issue incorporating many facets and stakeholders. On the basis of the results of a recent industry-focused research project on these issues, this paper describes the factors necessary to enable SCP as a reality and whether SCP can deliver on the Sustainable Development agenda.

**Keywords:** Sustainable Development; Sustainable Consumption and Production (SCP); Sustainable Product and Service Development (SPSD); eco-design; Life Cycle Management.

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## 1 Introduction

A key aspect of moving towards Sustainable Development is Sustainable Consumption and Production (SCP) and enabling us to meet our human needs in more sustainable ways. This is a complex issue incorporating many facets and stakeholders. The authors have recently completed an industry-focused research project on these issues (Maxwell, 2004) investigating:

- adverse environmental and social impacts associated with production and consumption
- the development of sustainable offerings (products and/or services) as one part of the SCP solution
- factors necessary for the development of sustainable products and services in a true Triple Bottom Line (TBL)<sup>1</sup> context and the rethinking required to move industry in this direction
- the role of industry-focused approaches, their limitations and the wider factors and stakeholders required to support the development of sustainable offerings and ultimately SCP.

The research produced a new TBL-focused Sustainable Product and Service Development (SPSD) approach for industry aimed at supporting the development of sustainable offerings, as well as knowledge on the wider aspects required to make SCP a reality. *A Guide for Developing Sustainable Products and Services in Industry* was published to communicate the SPSP approach providing industry with a practical, business-focused framework incorporating an implementation approach with a broad range of strategies for developing sustainable offerings (Maxwell, 2004, 2005).

The intention was to provide an industry support for one part of the sustainable production part of SCP. The SPSD approach and guide were developed and tested in industry during the research project. The testing used the SPSD approach to develop 10 offerings across 10 supply chains involving a total of 59 companies.

On the basis of this research, this paper describe:

- the adverse environmental and social impacts associated with production and consumption
- the role of SCP in tackling these impacts and moving towards Sustainable Development
- the factors necessary to enable SCP
- limitations of the Sustainable Development and SCP concepts in achieving the environmental and social improvements required.

## **2 Adverse environmental and social impacts from production and consumption**

It is now accepted that the production and consumption of products are key causal factors for many of the environmental and social problems we face today (Davidsson, 2002; DEFRA, 2003; EC, 1998, 2000, 2001a, 2003a; Elkington, 1997; Klein, 2001; Charter and Tischner, 2001; UNDESA, 2002; UNEP, 1997; WWI, 2004). Looking at consumption and production in general, the 2002 World Summit on Sustainable Development (WSSD), highlighted current patterns of consumption and production as unsustainable and resulting in adverse environmental and social impacts (UNDESA, 2002). This relates to both the production of products (the supply side) as well as their consumption by consumers (the demand side) and the interrelation between both sides. In a TBL sustainability context, these can be referred to as adverse sustainability impacts.

Adverse sustainability impacts can occur at many stages of the product life cycle – raw material acquisition, production, distribution, use and end of life reuse, recycling, treatment or disposal. The adverse environmental impacts associated with the production and consumption of products include climate change, waste generation, pollutant emissions to air and water, biodiversity loss and depletion of natural resources (EC, 2003a; Davidsson, 2002; DEFRA, 2003; UNDESA, 2002). These impacts can be exacerbated by other factors, for example, high population, high product consumption rates due to high consumer demand, global trade patterns, technological development and quickly changing consumer preferences. The extent of environmental damage caused is largely dependant on the type of product and the volume produced. In today's developed world, we manufacture a wide range of products in high volumes to satisfy increasing consumer demand and high population levels. In 2000, it was estimated that approximately 100 million products were on sale worldwide (Datschefski, 2000). The world's passenger car fleet is estimated at over 531 million, growing by 11 million vehicles per annum (WWI, 2004). One quarter of the global population (1.7 billion people) are part of the global consumer class, that is, using products, for example, TVs, telephones and the internet (WWI, 2004). Rapid technological development and quickly changing consumer preference can compound this problem by resulting in a high turnover of products, which become quickly obsolete. A classic example of this is the fast moving ICT, telecommunications and electronics industries where new models of

mobile phones and IT equipment, to name a few, replace their previous counterparts within months. An example of one of the adverse environmental impacts for these industries is the rapidly growing electronics waste stream or Waste Electrical and Electronic Equipment (WEEE) – identified as one of the fastest growing waste streams in the EU (EC, 2003a).

At present population and product consumption levels, it is already clear that the environment cannot sustain these adverse environmental impacts (Aloisi de Larderel, 2001; UNDESA, 2002). In particular, due to the earth's finite resources, material and energy consumption associated with product manufacture and its use is seen as key areas for achieving sustainability. In particular, increasing efficiencies in material and energy consumption towards a 'dematerialisation' of products (reducing the material and energy inputs) has been advocated for some time (van Hemel, 1998). Large reductions in material and energy consumption of the order of a factor 10–50 are advocated to support the sustainable consumption of goods and services for a global population that is forecast to reach 8 billion by 2040 (European Foundation, 1997; Hawken et al., 1999).

There are not only adverse environmental problems associated with production and consumption, there can also be adverse ethical and social issues such as child labour, discrimination, inequitable distribution of resources and inequitable trading policies (Klein, 2001; WWI, 2004). This is increasingly coming to light as an issue in line with globalisation and the increasing subcontract market in the developing world. In contrast to the 1.7 billion humans in the consumer society, 2.8 billion consume too little, suffer from poverty, hunger and homelessness (WWI, 2004).

### **3 Role of SCP and Sustainable Development**

The adverse sustainability impacts of production and consumption is a significant problem whose solution has many facets involving many stakeholders. Sustainable Development and SCP play a key conceptual and policy role in tackling these problems and moving towards a solution. Elements of the solution include the design and development of more sustainable ways to meet our human needs in the first place, creation of markets for more sustainable products and services, changing consumer behaviour, changing consumption and production patterns, technological innovations and new business models to contribute towards reversing unsustainable trends (Davidsson, 2002; DEFRA, 2003; Ryder, 2004; UNDESA, 2002). The holistic concept of Sustainable Solutions encompassing many of these elements has been proposed as a way forward (Charter and Tischner, 2001; Stahel, 2001).

At the big picture level, the concept of Sustainable Development is the current umbrella approach for moving towards a more sustainable future. Sustainable Development was first defined by the 1987 *World Commission on Environment and Development* report (the *Brundtland Report*) as:

“Development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987).

In terms of the production of products at industry level, proposals for how industry incorporates Sustainable Development into its approaches have been defined in a number of ways. Agenda 21 initially defined the role of business and industry in Sustainable Development as related to reducing their impact on resource use and the

environment (UNED, 1992). Since then a diverse range of approaches which aim to improve the sustainability performance of industry have evolved (Maxwell, 2004). This incorporates a diverse range of concepts and methods which aim to reduce the environmental impacts of industrial processes, products and services to varying degrees – one part of improving sustainability performance. This includes a shift to focus on products, as well as industrial processes, and the wider systems in which products and services operate. More recently, concepts and methods aimed at reducing the social impacts and increasingly the TBL sustainability impacts (environment, social and economic) associated with industry activities have evolved. Some definitions of TBL sustainability for business and industry are shown in Figure 1. In terms of developing sustainable products and services, a diverse range of approaches exist, which focus on reducing the environmental impacts of products, for example, eco-design/Design for Environment (Byggeth and Broman, 2000; Byggeth et al., 2000; Simon et al., 1998). Approaches focusing on reducing the more holistic sustainability impacts of products and services, for example, SPSD are only starting to emerge (Byggeth and Broman, 2000; Charter and Tischner, 2001; Maxwell, 2004; Simonsson and Barthel, 2002). This research revealed that the practical implementation of these approaches in industry are at different stages, with many companies focused on the environmental dimension of sustainability and using a diverse range of environmental improvement methods and tools. A smaller number of more innovative companies and typically large Multinational Corporations (MNC) are incorporating TBL sustainability approaches aimed at improving the sustainability performance of their activities in general (ADL, 2001; SustainAbility, 2001). In terms of the development of products and services, some innovative companies practise eco-design-type approaches (mainly in the form of eco(re)design where an existing product is redesigned with environment in mind) with a very small number focusing on more holistic sustainable product development approaches (Byggeth and Broman, 2000; Charter and Tischner, 2001; Maxwell, 2004; Simonsson and Barthel, 2002).

Under the Sustainable Development umbrella, SCP is the current system view proposed by the UN to tackle the sustainability impacts of production and consumption. SCP expands on previous policies by incorporating the entire commercial system products and services operate in and its interrelations (UNDESA, 2002). SCP is defined as:

“the production and use of goods and services that respond to basic human needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the lifecycle, so as not to jeopardise the needs of future generations” (UNEP and WBCSD, 1999, p.4).

The declarations from the 1992 Rio Earth Summit and Johannesburg WSSD both state that the reduction and elimination of unsustainable patterns of production and consumption are key to Sustainable Development. A commitment to development of a ten-year framework of programmes on SCP was made at WSSD (UNDESA, 2002). Development of these programmes has commenced at an international and EU level (UNDESA, 2003). As one of the first EU SCP framework approaches, the UK government defines the core of SCP as:

“continuous economic and social progress that respects the limits of the Earth’s ecosystems, and meets the needs and aspirations of everyone for a better quality of life, now and for future generations to come” (DEFRA, 2003).

**Figure 1** TBL Sustainability

*“Sustainability is the principle of ensuring that our actions today do not limit the range of economic social and environmental options open to future generations”* (Elkington, 1997, p.20). This is known as the *“Triple Bottom Line”* (TBL) in business as distinct from the traditional *“financial bottom line”* (Elkington, 1997). TBL provides a translation of Sustainable Development into a business context and focuses *“on economic prosperity, environmental quality and – the element which business has tended to overlook – social justice”* (Elkington, 1997, p.20). The term Quadruple Bottom Line incorporating economic, environmental, social and ethical performance is also used. TBL sustainability is the current mainstream concept for defining sustainability in business and industry.

*“Sustainable Development is one approach to meeting stakeholder expectations and developing long term prosperity. In essence companies taking a sustainable development approach to business are integrating their pursuit of three inter-connected goals: economic growth, environmental excellence and social responsibility”* (ADL, 2001, p.1).

*“Sustainable Development is a dynamic process which enables all people to realise their potential and improve their quality of life in ways which simultaneously protect and enhance the Earth’s life support systems”* (Forum for the Future, 2002, p.1)

#### 4 Enabling SCP

Practically enabling the SCP policy is the next step. As part of the research, the factors necessary to enable SCP were investigated. This included:

- factors for enabling the production of more sustainable offerings from industry
- push and pull factors necessary to motivate producers and consumers to develop and demand more sustainable offerings
- short- and long-term factors relating to infrastructure, technology, business and consumer models.

The factors were determined based on a critical analysis of information received from 106 data sources relevant to SCP issues to include literature, company personnel (41 companies), practitioners, academics and policy makers. On the basis of the analysis, two main types of factors called internal and external were determined (Maxwell, 2004). Internal factors focused on enabling the production of more sustainable offerings within industry at company and sectoral levels. External factors relate to the wider systems, infrastructure, policies, drivers and business models to promote and sustain the development of sustainable offerings in general. These involve a wider range of stakeholders, not just industry. The internal and external factors are listed in Figures 2 and 3.

Both the internal and external factors highlighted a number of existing barriers to developing sustainable products and services, as well as SCP in general (Maxwell and van der Vorst, 2003; Maxwell et al, 2003). To overcome these barriers, approaches for industry to support the development of sustainable offerings need to incorporate the

internal factors and the wider stakeholders need to create the external factors. In developing the SPSD approach and *Guide for Developing Sustainable Products and Services in Industry*, those factors that were relevant to an industry-focused approach for supporting the development of sustainable offerings were incorporated as this was seen as important to overcoming the internal barriers.

**Figure 2** Internal factors

1. Moving from a 'greening up' environmental focus to a TBL sustainability focus
2. Integrating TBL criteria with other traditional product and/or service criteria
3. Shifting the mindset of manufacturers from the provision of products to the provision of functions to meet human need
4. Moving from a focus on individual products to the systems in which products and services operate
5. Incorporation of all product and service life cycle stages
6. Increased focus on supply and value chains
7. Targeting approaches for developing sustainable offerings at appropriate companies based on the supply chain dynamics and their control of the product and/or service conception, design and development life cycle stages
8. Integration and coordination of supply chain organisations
9. A simple, flexible, non-resource intensive, customised approach in line with business realities
10. Use of business language suited to the company and industry sector culture
11. Incorporating a strategy level commitment to developing sustainable products and/or services and integrating SPSD with all business systems
12. Availability of resources and effective communication
13. Effective organisation and management internally and across the supply chain.

Source: Maxwell (2004).

**Figure 3** External factors

1. Strong legal and market drivers
2. Provision of a strong, clear business case for developing sustainable products and services
3. Changing operating models for business and consumers.

Source: Maxwell (2004).

#### 4.1 Internal factors

How the internal factors are incorporated in the SPSD approach and their role in supporting the development of sustainable offerings are summarised as follows:

- Overall, the SPSD approach shifts the focus to developing 'sustainable offerings' in a TBL context instead of 'greener products'. This incorporates all TBL elements (environment, social and economic) and integrates them with other traditional product and/or service criteria, for example, quality and technical feasibility to ensure industry requirements are met. This is a rethink of

existing approaches largely designed with only environment in mind to incorporate environmental and social issues in a TBL context, which was missing from existing approaches (Brezet et al., 2001; Byggeth and Broman, 2000; Charter and Tischner, 2001; Dobes and Majer, 2002; European Foundation, 1997; Simonsson, 2002; Simonsson and Barthel, 2002).

- Focusing on the environmental part of improving the sustainability performance of offerings, SPSD incorporates the factors identified as necessary for achieving more significant environmental improvements. These include consideration of functional and systems innovations as distinct from eco-efficiency improvements alone (Brezet et al., 1996; ECOLIFE, 2002) and incorporation of all life cycle phases using a closed loop, cradle-to-cradle approach (Braungart, 2002; Hanssen, 1999). This was identified as more effective than targeting isolated life cycle stages and their environmental impacts, for example, raw materials or end of life as in the case in most compliance driven EPD approaches in industry (EC, 2003a; European Foundation, 1997; Fava and Saur, 2002; McAloone, 2000; UNEP/SETAC, 2002). Examples of compliance driven approaches targeting isolated life cycle stages include the WEEE directive for electrical and electronic equipment<sup>2</sup> which primarily focuses on end of life or the RoHS Directive<sup>3</sup> for hazardous raw materials used in electronics. The incremental eco-efficiency improvements resulting from the mainly eco(re)design activities seen in the majority of industrial activity in this area to date are not seen as sufficient to resolve the associated environmental problems (Brezet et al., 2001; van Weenan, 1997). While providing clear incremental environmental (and economic) benefits, this approach can result in 'greening up' inherently unsustainable products making them 'less bad'. In many cases, the existence of the product itself is not environmentally suitable and just reducing specific environmental impacts associated with specific life cycle stages, for example, manufacture, disposal and end of life can be only scratching the surface of the problem, that is, treating symptoms, not solving the problem. Rebound effects can also occur where increased consumption of the greened products outstrips the environmental gains anyway (DEFRA, 2003). This approach is increasingly being seen as inadequate in terms of achieving long-term environmental, let alone TBL sustainability (Brezet et al., 2001; Byggeth et al., 2000; European Foundation, 1997; Hanssen, 1999; Hawken et al., 1999; McDonough and Braungart, 2002; van Weenan, 1997).
- Issues to be considered to achieve the functional innovations required include focusing on the provision of functions to meet human needs (as distinct from products) and system-based solutions. The concept of selling functions, as distinct from products, and providing functions to meet human needs by not just products, but alternatives, such as services or some combination (called Product Service Systems (PSS)) are increasingly promoted as important to achieving environmental improvements (Behrendt et al., 1997; Braungart, 2002; Brezet and van Hemel, 1997; Brezet et al., 2001; Engelhardt and Hammerl, 2002; Hawken et al., 1999; Mont, 1999; Reiskin et al., 2000; Stahel, 1997; van den Hoed, 1997; van Weenan, 1997). In terms of systems, instead of focusing on improving the environmental performance of individual products, focusing on improving the performance of the families of products (van Weenan, 1997) and the entire systems they interact in is advocated (Brezet et al., 2001; European Foundation, 1997; Hanssen, 1999; Mont, 2002; van den Hoed, 1997). The delivery of system-focused offerings incorporating a product, service or PSS



and the infrastructural, consumer, institutional, network and user behaviour context within which it operates is seen as necessary for environmental improvements (Brezet et al., 2001; Mont, 2002). It is recognised that there are uncertainties in terms of proven sustainability benefits and the ability of manufacturers and consumers to shift towards systems innovations (Mont, 2002). Research indicates that significant environmental improvements are possible by the provision of functions through services and PSS, as distinct from products alone (Behrendt et al., 2003; Brezet et al., 2001; EC, 2003d; Goedkoop et al., 1999; Meijkamp, 2000; Mont, 1999; Reiskin et al., 2000), but a few practical success stories are currently available (Mont, 2002). Rebound effects have also been associated with this approach (Hopkinson and James, 2000) and potentially negative social impacts. Owing to the potential for a significant environmental benefit, the functional and systems criteria were incorporated in the SPSD approach. An open mindset not focused on any one method of function provision (services, products or PSS) and assessment of both positive and negative environmental and social impacts was also incorporated to ensure potential negatives would be identified.

- SPSD takes into account the fact that in product and/or service development there are a range of organisations operating in supply chains with different roles, and abilities to control key design issues relevant to sustainability. Because of this and the requirement to consider functionality, systems and the entire life cycle, the importance of implementing SPSD in the organisation with control over the offering conception and its design was identified (Charter et al., 2001; Laurent and Duckers, 2000; Morton, 1999; Shapiro and White, 1997). In light of the supply chain nature of offering development, the incorporation of key supply and value chain organisations, for example, suppliers to customers in the implementation process and supply chain management of these was also included (Brezet et al., 2001; Charter et al., 2001; DEFRA, 2002; Dobes and Majer, 2002; ECOLIFE, 2002; McAloone, 2000; Simonsson and Barthel, 2002; Stevels, 2000). For these reasons, SPSD shifts the focus for developing sustainable offerings to the supply and value chain rather than on individual companies alone, thereby engaging a wider group of key supply chain stakeholders. SPSD implementation activities are targeted based on the supply chain role and in particular the control a company has over the offering development stages key to sustainability improvements. This shift in focus away from an individual company alone (which traditional environmental performance improvement methods target) to the offering supply chain is a paradigm shift in how we apply sustainability approaches in product and/or service development.
- In addition to the factors identified as necessary for achieving environmental and social benefits, a range of factors relating to meeting additional industry requirements and facilitating the implementation to achieve a more sustainable result were incorporated to include:
  - The SPSD approach structure itself is a practical, qualitative framework of suggested actions backed by supporting information and a toolbox. It is a flexible approach designed to be customised to the company offering, culture and existing offering development systems.
  - A strategic approach with the development of sustainable products and/or services as a corporate aim, which is integrated into existing business systems and their performance targets are advocated.

- Guidance on effective organisation, management, planning, resources and communication internally and across the supply chain is provided.
- Relevant introductory and ongoing information to engage and support the implementation (to include the business case for developing sustainable offerings, legal and market drivers, industry case examples, support tools and SPSD information database) is incorporated in the implementation process.
- To facilitate effective communication, using business language suited to the company/industry culture and minimising new jargon is advocated.

The new SPSD approach incorporates all these factors together to provide an industry support for developing sustainable offerings. This incorporates a wide range of strategies for maximising environmental and social performance in offerings.

#### 4.2 *External factors*

Solutions aimed at reducing the adverse sustainability impacts of production and consumption involve a diverse range of problems, policies, instruments and stakeholders (Davidsson, 2002; Ryder, 2004). The external factors highlight the wider aspects that need to be in place, for example, push and pull factors, in addition to industry supports, for example, SPSD, to enable SCP. Increased pressures from legal and market drivers (especially from customers) were identified as necessary to motivate industry to develop sustainable products and/or services (Hanssen, 1997; Stevels, 2000; McAloone, 2000). The UK *BSI* survey of sustainable product development-type industry activities showed external drivers, for example, legislation as the most common factor for initiating and maintaining these activities (Simonsson and Barthel, 2002). In most of the countries, there is an increasing focus on legal drivers aimed at specific environmental impacts of products. Taking the EU as an example, Integrated Product Policy (IPP) (EC, 2003a) is the umbrella policy setting the framework for tackling the environmental impacts of products. A key concept within this is Extended Producer Responsibility (EPR) whereby the producer's (i.e. product manufacturer's) responsibility is extended from environmental impacts generated at the production facility to those associated with other phases of the product life cycle. This is designed to motivate the producer to eliminate or minimise environmental impacts when designing the product, thereby minimising the impacts across the life cycle. To date EPR-focused legislation has been phased in for a range of environmentally problematic products to include:

- packaging (Council Directive 94/62/EC on Packaging and Packaging Waste (EC, 1994))
- vehicles (Council Directive 2000/53/EC on End-of Life Vehicles (ELV) (EC, 2000))
- electronics (Council Directive on 2002/96/EC WEEE (EC, 2003b) and Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) (EC, 2003c))
- Energy using Products (EuP) (e.g. heating, lighting, motors, electronics and air conditioners) (Council Directive 2005/32/EC establishing a framework for setting eco-design requirements for EuP and amending Council Directives 92/42/EEC, 95/57/EC and 2000/32/EC (EC, 2005)).

The packaging, ELV and WEEE Directives mainly target the end of life issues associated with these products and the producer is responsible for environmentally sound end of life management to include its financing. RoHS (and the packaging directive to a certain extent) targets the raw material stage. Recently, eco-design requirements for EuP directive has a more evolved approach, which requires the environmental impacts of all life cycle stages to be assessed and opportunities for improvements made, with a particular focus on energy improvements and which do not adversely impact the functional and economic product characteristics. This directive is to be implemented in the EU Member States by 2007 and compliance is to be built into the CE marking scheme (EC, 2005).

Green procurement requirements, financial instruments and labelling are examples of advocated market initiatives (EC, 2003a). Market drivers for environmental performance improvements in products and services are slowly increasing. Existing examples include the financial cost of end of life management under EPR legislation, corporate reputation concerns, supply chain pressures from customers to demonstrate good sustainability performance (or aspects of it) and increasing consumer awareness. A range of voluntary market initiatives to manage and demonstrate sustainability performance in general with some focusing on products and services have developed in response to these drivers. Examples include:

- Environmental Management Systems, for example, ISO14001 providing a specification for environmental management of processes, products and services with the Guide ISO/TR 14062 *Integration of Environmental Aspects into Product Design and Development* (ISO, 2002) focusing specifically on products.
- Labels specifying the environmental and/or to a smaller extent social credentials of a product or service. Examples include the *Energy Star* (office equipment), *EU Energy Label* (white goods: refrigerators, washing machines and dryers), *VOC paint label*, *Organic* (food), *Fair Trade*, *Forest Stewardship Council* (timber products) and EU Eco label (for 21 products and tourism) (EC Eco-label, 2004).
- Corporate Social Responsibility (CSR) (or Corporate Responsibility (CR)) providing a method and toolbox for achieving Sustainable Development in industry (BITC, 2003; EC, 2001c) with an ISO standard under development.
- Standards providing a specification for identifying and managing social impacts, for example, *AA1000 Series* for accountability and stakeholder engagement (AccountAbility, 2002) and *SA8000* (SAI, 2002) aimed at certifying labour practices in companies, their subsidiaries, suppliers and vendors.

The need for new business and consumer models involving a much wider group of stakeholders to support the transition towards provision of functionality as distinct from products, through system-based offerings was identified (Brezet et al., 2001; Dobes and Majer, 2002; Mont, 2002). These models feature the following characteristics:

- business success not being based on the bottom line alone (Braungart, 2002; Elkington, 1997; Hawken et al., 1999)
- a time factor shift to focus on longer-term profit versus short-term (Brezet et al., 2001)

- business coalitions, networking and interaction with a wider group of stakeholders (Brezet et al., 2001; Dobes and Majer, 2002)
- greater consumer involvement, education and information to shift the mindset of consumers from being owners of products to being users of system offerings (products, services or PSS) (Mont, 2002).

From an environmental perspective, the external factors identified are consistent with Ecological Modernisation theories, which propose a framework for Sustainable Development requiring transformation of social, political, technical and economic parameters. In particular, for environmental improvement, this promotes a transformation of policies (e.g. those relating to science and technology and production and consumption), changing roles of institutions and incorporating new stakeholders as change agents for environmental reform (not only the traditional role of government, but also other stakeholders such as the private sector, e.g. industry, insurers and bankers), political modernisation, for example, flexible decentralised governance structures versus the more traditional top down and technical innovations (Barry and Paterson, 2003; Mol and Sonnenfeld, 2000).

The external factors identified in the research show that there is a range of elements necessary for enabling SCP. Developing SPSPD concepts and industry supports focuses on one aspect of the problem – production of products and/or services in industry – and is one element contributing towards a more sustainable solution. It shifts the focus from the individual company level, to the supply and value chain level. In the wider business and consumer models suggested for SCP, the focus needs to shift to engage the wider institutional stakeholders with networked interaction (Brezet et al., 2001; Dobes and Majer, 2002; Ryder, 2004).

## **5 Can SCP and Sustainable Development deliver?**

Assuming the factors necessary for enabling SCP are achieved, can SCP and Sustainable Development effectively tackle the adverse environmental and social products associated with production and consumption? In terms of industry producing offerings with improved environmental and social performance, the research shows that the extent that this can be achieved is influenced by a range of issues and in particular the lack of external factors currently in place. Also, fundamental conflicts in the TBL sustainability concept embodied in Sustainable Development and SCP, which can limit the environmental and social performance improvement achievable were also highlighted.

A range of influencing factors was identified from the SPSPD approach industry testing as limiting the resulting environmental and social benefits that were achievable. These are summarised as follows:

- Traditional criteria such as cost, technical feasibility problems, the lack of raw material options and meeting customer requirements all limited the environmental and social performance improvement achievable. This was identified as unavoidable at present as meeting traditional criteria; for example, cost is necessary to product and/or service providers working in a market economy. Perhaps in a less economically dominated paradigm where value is measured also by non-economic parameters and improved technology options are available, greater environmental benefits could be achieved. Innovations in

technology aimed at providing raw materials and processes enabling the technical feasibility to maximise environmental performance are required (Ryder, 2004).

- When integrating traditional criteria with environmental and social criteria, different priority weightings were given to the criteria based on the company requirements. A higher priority weighting was given to meeting offering criteria such as customer requirements, market demand, cost and current compliance obligations compared to non-compliance-related environmental and social criteria.
- Outside of environmental compliance requirements, an association between improving efficiencies and resulting cost benefits was observed to determine which environmental improvements were made. This relates to higher priorities being allocated to economic benefit compared to non-compliance-related environmental benefit.
- There is a lack of drivers and a business environment conducive to motivating companies to start by considering the function to meet a human need, consider all life cycle stages in a closed loop cradle-to-cradle approach and incorporate wider systems interactions. The extent to which these factors can be incorporated in offering development is limited by this, however, their incorporation is important to achieving improved sustainability performance. Without the wider infrastructure, drivers, business and consumer models, the contribution to a more sustainable offering that considering these in offering development makes is limited. It is proposed that if (and when?) these wider elements are in place, their consideration as part of the offering development process would enable a greater contribution to maximising the environmental and social performance of offerings.
- Specifically, there is a lack of drivers for companies to consider the environmental impacts across the entire life cycle, as distinct from focusing on specific life cycle stages, for example, end of life or raw materials. Current legal and market drivers aimed at environmental performance improvement focus on reducing the environmental impacts of specific life cycle stages, for example, end of life in the WEEE directive for electronic equipment (EC, 2003c) or raw materials in the RoHS Directive (EC, 2003c) for hazardous substances used in electronics. While policy initiatives, for example, IPP (EC, 2003a) and UNEP/SETAC Life Cycle Initiative (UNEP/SETAC, 2002) advocate Life Cycle Thinking incorporating all life cycle stages, industry did not see these as drivers to implement this approach. This lack of drivers resulted in certain life cycle stages (e.g. raw material acquisition) being perceived as outside the scope of the producer's responsibility. The implementation of the eco-design requirements of EuP directive (EC, 2005) in the EU, which incorporates all life cycle stages may have a positive impact on this for EuPs.
- Difficulty in gaining accurate information on alternative raw materials, components and assemblies from supply chain companies and other sources were limiting factors in identifying and assessing potentially more sustainable options.
- There are increased drivers for environmental improvements compared to social ones. Industry did not have explicit drivers to improve social performance,

outside of employee health and safety-related drivers, for example, health and safety legislation and the financial liability of health and safety-related accidents.

- Excluding health and safety-related social impacts, there is increased comfort and a sense of responsibility for considering environmental impacts compared to social, especially for social impacts associated with supply chain activities in other countries. A lack of legal drivers for the offering producer to take responsibility for social issues outside of the companies plant and locality and hence a reluctance to incorporate global social impacts occurring along their supply chains was identified as a feature limiting incorporation of social impact criteria in offering development in practice. Voluntary market initiatives, for example, CSR, AA1000, SA8000 or labelling were not a strong driver in these cases for including social issues.
- A further limiting feature was difficulty in obtaining information to fully assess the social impacts across all life cycle stages.

The SPSD industry approach provides guidance and supports aimed at achieving a more sustainable result. The other influencing factors are important to determining the extent to which the supports and strategies within it are fully implemented, as well as the sustainability of the final offering. A lack of drivers is seen as a significant barrier for companies towards motivation to develop more sustainable offerings. In particular, the influences relating to social impacts highlight a challenge on how to get companies to embrace the wider social dimension of sustainability when there is a lack of effective, external drivers to do this.

At the big picture level, fundamental limitations about the TBL sustainability and Sustainable Development concepts in terms of maximising environmental and social performance by integrating environmental and social criteria with economic issues were identified by the research. On the economic side alone, limitations to maximising environmental and social performance were due to commercial feasibility requirements being a necessity in a market economy. Recent SCP debate has also highlighted failures in the capital markets system and an associated inherent conflict with business as key barriers to SCP (Ryder, 2004). While the TBL integration facilitates the practical implementation of the Sustainable Development concept in the market economy, it is unlikely to achieve the environmental and social performance required, in particular the minimum Factor 10 environmental improvement advocated as necessary to support an expected 8 billion population by 2040 (European Foundation, 1997; Hawken et al., 1999). This requires a rethink of the TBL sustainability concept and its ability to deliver the environmental and social improvements required. This has fundamental implications for how we measure value, wealth, success and the role of economic and other indicators to do this. The role of current indicators, for example, Gross National Product (GNP) or Gross Domestic Product (GDP)<sup>4</sup> as measures of economic success based on the value of goods and services produced in a country per annum pose conflicts in terms of SCP and Sustainable Development. Incorporation of other indicators, to include community wealth, environmental and social capital and how we ensure the required prioritisation of these factors in practice, need to be determined (Braungart, 2002; Elkington, 1997; Hawken et al., 1999; WWI, 2004). A reevaluation of human needs and wants is part of this equation with new definitions for how consumers and producers measure value reflected in new business and consumer models. The new

business and consumer models highlighted as external factors identified business success being measured by generation of community wealth, protection and restoration of natural systems and leadership as distinct from the bottom line alone (Braungart, 2002; Elkington, 1997; Hawken et al., 1999). Recently, amendments to the EU Sustainable Development Strategy to include elements such as quality of life and resource use in the methodology currently used for assessing growth and productivity have been recommended (EC, 2001b; ENDS, 2004; Ryder, 2004).

## **6 Conclusions**

SCP within the SD umbrella is the current policy approach for tackling the adverse sustainability impacts associated with production and consumption. One of the outcomes of this research was the identification of factors for enabling SCP. These include internal factors relating to sustainable production approaches implemented in industry for developing sustainable offerings and external factors relating to the wider systems necessary to drive and sustain the production and consumption of sustainable offerings. Enabling SCP encompasses effective sustainable production industry approaches to support the development of sustainable offerings in the first place as well as the physical infrastructure, technology innovations, diverse policy, legal and market instruments, new business and consumer models all incorporating the factors necessary to motivate producers and consumers, and involving wide system level stakeholder engagement. As the research industry testing illustrated, without these external factors, the contribution to a more sustainable offering that can be made through using industry support approaches is very limited.

The research conclusions highlight recommendations for a wide range of stakeholders – policy makers, researchers, industry, consumers, NGOs, etc. From a policy context, a review of the TBL Sustainable Development concept and developing SCP policies in terms of their ability to achieve the required environmental and social results is recommended for international policy makers, for example, UNEP and at EU level through the European Commission (e.g. DG Environment and DG Enterprise). The market economy conflict needs greater analysis and alternatives to be considered. To bring together all the parts of the jigsaw necessary to move towards SCP, it is recommended that a wide range of stakeholders, in particular policy makers, focus on creating the wider business environment encompassing the push and pull factors necessary to motivate producers and consumers to develop and demand more sustainable offerings. This encompasses short- and long-term agendas relating to infrastructure, technology, business and consumer models and changing consumer behaviour.

## **References**

- AccountAbility (2002) *AA1000 Standard*, London: AccountAbility, ISBN 19016930112.
- ADL (2001) *Realising the Business Value of Sustainable Development – An Arthur D. Little Survey on Sustainable Development in Business*, Arthur D. Little.
- Aloisi de Larderel, J. (2001) 'Foreward from UNEP director of technology industry and economics', in M. Charter and U. Tischner (Eds). *Sustainable Solutions*, UK: Greenleaf Publishing, ISBN 1874719365.

- Barry, J. and Paterson, M. (2003) 'The British state and the environment: new labour's ecological modernisation strategy', *International Journal of Environment and Sustainable Development*, Vol. 2, No. 3, pp.237–249, ISSN 1474 6778.
- Behrendt, S., Jasch, C., Peneda, M. and van Weenan, H. (1997) *Life Cycle Design for SMEs*, Germany: Springer Verlag, ISBN 3540627936.
- Behrendt, S., Jasch, C., Kortman, J., Hrauda, G., Pfitzner, R. and Velte, D. (2003) *Eco-service Development, Reinventing Supply and Demand in the European Union*, Greenleaf Publishers, ISBN 1874719446.
- BITC (2003) 'Business in the Community CSR guidance', Available at: <http://www.bitc.org.uk/index.html>. Accessed on 20 March 2003.
- Braungart, M. (2002) 'Reinventing the world: building a hopeful path to prosperity with innovative design', *European Round Table on Cleaner Production 2002, Conference Proceedings*, 8–11 October, Ireland, Clean Technology Centre.
- Brezet, J.C., Cramer, J. and Stevels, A. (1996) *From Waste Management to Environmental Innovation*, The Hague, Rathenau Institute, ISBN 9034633055.
- Brezet, H. and van Hemel, C. (1997) *Ecodesign: A promising Approach to Sustainable Production and Consumption*, France: UNEP, United Nations Publication, ISBN 92-807-1631-X.
- Brezet, J.C., Bijma, A.S., Ehrenfeld, J. and Silvester, S. (2001) *The Design of Eco-Efficient Services – Method, Tools and Review of the Case Study from Designing Eco-Efficient Services Project*, The Netherlands: Design for Sustainability programme, Delft University of Technology.
- Byggeth, S.H. and Broman, G. (2000) 'Environmental aspects in product development – an investigation among small and medium sized enterprises', *SPIE International Symposium on Intelligent Systems and Advanced Manufacturing; Environmentally Conscious Manufacturing, Conference Proceedings*, 5–8 November 2000, Boston.
- Byggeth, S.H., Broman, G., Holmberg, J., Lundqvist, U. and Robèrt, K-H. (2000) 'A method for sustainable product development in small and medium sized enterprises', *TMCE – Tools and Methods of Competitive Engineering*, Symposium, 18–21 April 2000, Delft University, The Netherlands.
- Charter, M. and Tischner, U. (Eds) (2001) 'Sustainable product design', *Sustainable Solutions*, UK: Greenleaf Publishing, ISBN 187419365.
- Charter, M., Young, A., Kielkiewicz-Young, A. and Belmane, I. (2001) 'Integrated product policy and eco-product development', in Charter, M. and Tischner, U. (Eds). *Sustainable Solutions*, UK, Greenleaf, 2001, ISBN 18741936
- Datschefski, E. (2000) *Greenerbydesign*, Available at: <http://www.biothinking.com/index.htm>. Accessed on 30 August 2000.
- Davidsson, B. (2002) *Towards Sustainable Products in Sweden*, Sweden: Swedish EPA, Sustainable Consumption and Production Section.
- DEFRA (2002) 'Action for greener products: a tool box for change', *Advisory Committee on Consumer Products and the Environment Second Report*, April, UK: DEFRA.
- DEFRA (2003) *Changing Patterns – UK Government Framework for Sustainable Consumption and Production*, PB 8733, September, DEFRA Publications, UK.
- Dobes, V. and Majer, H (2002) 'A framework for analysing the relations between networks, learning, innovation and sustainable production', *European Round Table on Cleaner Production, Conference Proceedings*, 8–11 October 2002, Clean Technology Centre, Ireland.
- EC (1994) *Council Directive 94/62/EC on Packaging and Packaging Waste*, OJ No L 365, 31 December, Brussels: European Commission, pp.10–23.
- EC (1998), *Integrated Product Policy Final Report*, Ernst and Young, March 1998, Science Policy Research Unit, European Commission: DGXI.
- EC (2000) *Council Directive 2000/53/EC on End-of Life Vehicles*, OJ L269, 21 October, Brussels: European Commission, pp.34–43.



- EC (2001a) *EU Sixth Environmental Action Programme Environment 2010: Our Future, Our Choice*, 24 January, Brussels: European Commission.
- EC (2001b) *Communication from the Commission a Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development*, COM, 264 final, 15 May 2001, Brussels: European Commission.
- EC (2001c) *Promoting a European Framework for Corporate Social Responsibility*, Green Paper, July, Brussels: European Commission, DG for Employment and Social Affairs.
- EC (2003a) *Communication from the Commission: Integrated Product Policy Building on Life Cycle Thinking*, COM, 302 Final, June 2003.
- EC (2003b) *Council Directive on 2002/96/EC Waste from Electrical and Electronic Equipment (WEEE)*, OJ L37, 13 February, Brussels: European Commission, pp.24–38.
- EC (2003c) *Council Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)*, 13 February, OJ L37, Brussels: European Commission, pp.19–23.
- EC (2003d) *Study on External Environmental Effects Related to the Life Cycle of Products and Services Final Report*, February, Brussels: European Commission, DG Environment.
- EC (2005) *Council Directive 2005/32/EC Establishing a Framework for Setting Ecodesign Requirements for Energy Using Products (EuP) and Amending Council Directives 92/42/EEC, 95/57/EC and 2000/32/EC*, 22 July, OJ L191, pp.29–59, Brussels: European Commission.
- ECOLIFE (2002) *EcoDesign Guide: Environmentally Improved Product Design Case Studies of the European Electrical and Electronics Industry*, July, ECOLIFE Thematic Network.
- Elkington, J. (1997) *Cannibals with Forks, the Triple Bottom Line of 21st Century Business*, UK: Calstone Publishing Limited, ISBN 1-900961-27-X.
- ENDS (2004) 'EU urged to step up action on sustainability', *ENDS Environment Daily*, No. 1659, 03 May.
- Engelhardt, G. and Hammerl, B. (2002) 'Eco-efficient services: the development of innovative business fields, STENUM GmbH and JOANNEUM RESEARCH', *European Round Table on Cleaner Production, Conference Proceedings*, Clean Technology Centre, Ireland.
- EU Eco-label (2004) 'Homepage of the EU ecolabel', Available at: <http://www.europa.eu.int/comm/environment/ecolabel/index.htm>. Accessed on 31 July 2000, 20 May 2003 and 20 September 2004.
- European Foundation (1997) *Design for Sustainable Development, Concepts and Ideas*, Ireland: European Foundation for the Improvement of Living and Working Conditions, ISBN 9282808610.
- Fava, J. and Saur, K. (2002) *UNEP/SETAC Life-Cycle Initiative successfully Launched in Prague*, Germany: Five Winds International, Available at: [www.fivewinds.com](http://www.fivewinds.com). Accessed on 20 June 2002.
- Forum for the Future (2002) 'Sustainable Development policies and mission statements', Available at: <http://www.forumforthefuture.org.uk/aboutus/default.asp?pageid+309>. Accessed on 18 July 2002.
- Goedkoop, M., van Halen, C., te Riele, H. and Rommens, P. (1999) *Product Service Systems – Ecological and Economic Basis*, Report No. 1999/36.
- Hanssen, O.J. (1997) 'Sustainable industrial product systems', PhD Thesis, Norwegian University of Science and Technology, Norway, ISBN 8275203031.
- Hanssen, O.J. (1999) 'Sustainable product systems – experiences based on case projects in sustainable product development', *Journal of Cleaner Production*, Vol. 7, pp.27–41.
- Hawken, P., Lovins, A. and Lovins, L. (1999) *Natural Capitalism the Next Industrial Revolution*, UK: Earthscan Publications Ltd., ISBN 1853837636.
- Hopkinson, P. and James, P. (2000) 'Typology of eco-efficient services', Working Paper, University of Bradford, UK.

- ISO (2002) ISO /TR 14062 *Integration of Environmental Aspects into Product Design and Development*, Switzerland: ISO.
- Klein, N. (2001) *No Logo*, UK: Flamingo Publishing, ISBN 0 00 6530400.
- Laurent, S. and Duckers, L. (2000) 'SMEs and the environmental challenge: muddling through the systems dynamics of the innovation process', *Proceedings of Sustainable Development SMEs and New Enterprises*, Ireland, 12–13 October 2000, European Foundation for Living and Working Conditions.
- Maxwell, D. (2004) 'Developing sustainable products and services in industry', PhD Thesis, December, Imperial College London, UK.
- Maxwell, D. (2005) *Guide for Developing Sustainable Products and Services in Industry*, Available at: [www.sustainableproductsandservices.com](http://www.sustainableproductsandservices.com).
- Maxwell, D. and van der Vorst, R. (2003) 'Developing sustainable products and services', *Journal of Cleaner Production*, Vol. 11, No. 8, pp.883–895.
- McAloone, T.C. (2000) *Industrial Application of Environmentally Conscious Design*, UK: Professional Engineering Publishing Ltd., ISBN 1860582397.
- McDonough, W. and Braungart, M. (2002) *Cradle to Cradle Remaking the Way We Make Things*, New York: North Point Press, ISBN 0-865475873.
- Meijkamp, M. (2000) 'Changing consumer behaviour through eco-efficient services: an empirical study on car sharing in The Netherlands', PhD Thesis, Delft University of Technology.
- Maxwell, D., van der Vorst, R. and Sheate, W. (2003) 'Sustainable innovation in product and service development, sustainable innovation 03', *Towards Sustainable Product Development # 8*, conference proceedings, October, Stockholm, CfSD, pp.28–29.
- Mol, A. and Sonnenfeld, D. (2000) *Ecological Modernization Around the World: An Introduction Perspectives and Critical Debates*, Frank Cass Co., ISBN 0-7146-8113-X.
- Mont, O. (1999) *Product-Service Systems, Shifting Corporate Focus from Selling Products to Selling Product Services: A New Approach to Sustainable Development*, December, Sweden, AFR Report No. 288.
- Mont, O. (2002) 'Clarifying the concept of product-service system', *Journal of Cleaner Production*, Vol. 10, No. 3, pp.237–245.
- Morton, B. (1999) 'Environmental supply chain forum: CROMTEC', *Eco-Design and Supply Chain Management, Conference Proceedings*, UK, 28 June.
- Reiskin, E., White, A., Kauffman, J. and Votta, J. (2000) 'Servicizing the chemical supply chain', *Journal of Industrial Ecology*, Vol. 3, Nos. 2/3.
- Ryder, B. (2004) 'Sustainable development strategies and the role of sustainable consumption and production', *European Roundtable on Sustainable Consumption and Production, Conference Proceedings*, May 2004, Bilbao, IHOBE.
- SAI (2002) 'Social accountability international', Available at: [www.cepaa.org](http://www.cepaa.org). Accessed on 10 May 2002.
- Simon, M., Evans, S., McAloone, T., Sweatman, A., Bhramra, T. and Poole, S. (1998) *Ecodesign Navigator*, UK: EPSRC, Deanprint, ISBN 871315-74-3.
- Simonsson, A. and Barthel, M. (2002) 'Organisational aspects of the application of sustainable product development and design', *Towards Sustainable Product Design #7, Conference Proceedings*, October 2002, BSI, London, CfSD.
- Simonsson, A. (2002) *Application of sustainable product development and design: A pilot study of the art, barriers and enablers*, Linköping, Sweden, Unitryck.
- Shapiro, K. and White, A. (1997) 'Pathway to product stewardship: life-cycle design as a business decision-support tool', *Report to the US EPA*, November, Tellus Institute, pp.1–2.
- Stahel, W. (1997) 'The service economy: "wealth without resource consumption?"' *Philosophical Transactions*, Vol. 355, Royal Society of London, June, pp.1309–1319.

- Stahel, W. (2001) 'From "design for environment" to "designing sustainable solutions"', in M. Tolba (Ed). *Our Fragile World: Challenges and Opportunities for Sustainable Development*, Vol. II, EOLSS Publishers Co. Ltd., pp.1553–1568, ISBN 0953494454.
- Stevens, A. (2000) *Applied Ecodesign at Philips Consumer Electronics and Delft University of Technology: Ten Years of Dynamic Development*, Design for Sustainability Research Group, Delft University, The Netherlands.
- SustainAbility (2001) 'SustainAbility', Available at: <http://www.sustainability.co.uk/home.asp>. Accessed on 04 May 2001.
- UNDESA (2002) *Plan of Implementation of the World Summit on Sustainable Development*, UN Department of Economic and Social Affairs, Division for Sustainable Development.
- UNDESA (2003) *International Expert Meeting on the 10 year Framework Programme for Sustainable Consumption and Production*, Marrakech, Morocco, 16-19 June 2003, UNDESA
- UNED (1992) *Agenda 21, Action Programme of the UN Conference on Environment and Development (UNCED)*, UNED.
- UNEP (1997) *Ecodesign: A Promising Approach to Sustainable Production and Consumption*, UNEP I&E, Delft University of Technology, Rathenau Institute, ISBN 92-807-1631-X.
- UNEP and WBCSD (1999) *Eco-Efficiency and Cleaner Production: Charting the Course to Sustainability*, France: United Nations Environment Programme and World Business Council for Sustainable Development.
- UNEP/SETAC (2002) 'UNEP/SETAC life-cycle initiative', Available at: <http://www.uneptie.org/sustain/lca/lca.htm>.
- Van den Hoed, R. (1997) 'An exploration of approaches towards Sustainable Innovation and their implication in the product development process', *Fifth Greening of Industry Network Developing Sustainability: New Dialogues, New Approaches, Conference Proceedings*, Germany.
- van Hemel, C. (1998) 'Ecodesign empirically explored', *Design for Environment in Dutch SMEs*, Amsterdam: Boekhandel MilieuBoek, ISBN 90-9011667-2.
- van Weenan, H. (1997) 'Sustainable product development: opportunities for developing countries', *UNEP Industry and Environment Review*, January–June.
- WCED (1987) *World Commission on Environment and Development: Our Common Future*, New York: Oxford University Press.
- WWI (2004) *World Watch Institute State of the World 2004 – Special Focus: The Consumer Society*, January, WWI, ISBN 0393325393.

## Notes

<sup>1</sup>TBL provides a translation of Sustainable Development into a business context focusing on environment, social and economic issues as a TBL as distinct from the solely economic bottom line (Elkington, 1997).

<sup>2</sup>Council Directive on 2002/96/EC WEEE (EC, 2003b).

<sup>3</sup>Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) (EC, 2003c).

<sup>4</sup>GNP is the US indicator and GDP is the European.