Sustainable Innovation

Key conclusions from Sustainable Innovation Conferences 2003–2006 organised by The Centre for Sustainable Design

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Contents

1 Introduction

This booklet summarises the key conclusions from the 2003–2006 conferences on *Sustainable Innovation* organised by The Centre for Sustainable Design (**www.cfsd.org.uk**). The conclusions are drawn from the respective conference presentations, papers and discussions. The publication has been sponsored as part of a 'Centre of Excellence in Sustainable Innovation & Design' project awarded to The Centre for Sustainable Design by the South-East England Development Agency (SEEDA).

Sustainable Innovation **conferences**

The Centre for Sustainable Design (CfSD) was established in 1995 and one of the early needs it identified was for an annual (European) conference related to the design and development of sustainable products. As a result, the Centre organised a series of international conferences under the brand of Towards Sustainable Product Design (TSPD). From 2003 the events were re-branded under the title of *Sustainable Innovation*.

In 2001, CfSD decided to add themes to the conferences and subsequently focused on Product-Service-Systems (Amsterdam, the Netherlands, 2001), Management (London, UK, 2002), Innovation (Stockholm, Sweden 2003), New Business Models (Farnham, UK, 2004), State of the Art (Farnham, 2005), and on Global Developments (Chicago, USA, 2006). Construction and Buildings is the theme for the 2007 conference in Farnham, UK (the 12th conference in the series).

The 2006 conference in Chicago was the first time the event had been taken out of Europe.

The continued success of the programme has been the result of wide sponsorship and support from the following:

- Government and regional agencies, including Department of Environment, Food and Rural Affairs (DEFRA); Department of Trade & Industry (DTI); the Government Office for the South-East (GOSE), Ministry of Environment (Sweden); Nordic Council of Ministers; and South-East England Development Agency (SEEDA).
- Other organisations, including British Standards Institute (BSI); Buckinghamshire & Berkshire Sustainable Business Partnership; Delft University of Technology; e(c)oncept; Future 500; Hampshire Natural Resources Initiative; 02 Global Network; Oxfordshire Sustainable Business Partnership; Stuart School of Business at Illinois Institute of Technology; Stuttgart Design Centre; Sustainable Trade & Innovation Centre (STIC); Surrey Economic Partnership; Swedish Business Development Agency (NUTEK); the United Nations Environment Programme (UNEP); West Sussex Sustainable Business Partnership; World Business Council for Sustainable Development (WBCSD); and Waste & Resource Action Programme (WRAP).

The conferences have included presentations by invited speakers and papers refereed by expert advisory panels. Speakers and authors have included leading-edge international designers, inventors, academics and managers. Among delegates, the conferences has attracted worldwide participation from large companies, entrepreneurs and small and medium-sized enterprises (SMEs), as well from creative industries, venture capital, governments, higher education and non-governmental organisations. To date over 1300 delegates have attended from over 40 countries.

From 2005 it was decided to choose only the 30 top ranked refereed papers to maintain high quality.

Aims and benefits

The conferences aimed to present new thinking and best practice in *sustainable innovation* and related topics as well as to stimulate discussion. The continuing focus has been on raising the awareness and understanding of the opportunities for and obstacles to *sustainable innovation* by presenting experience and new ideas from both developed and developing countries.

Benefits have included:

- Providing high quality information that will be useful to national environmental product policy (EPP) and Integrated Product Policy (IPP) discussions internationally
- Helping to raise awareness of the multi-faceted aspects of the issues and reinforcing the need for *sustainable innovation* to be incorporated into the Sustainable Consumption and Production (SCP) policy debate
- Introducing new concepts, approaches and knowledge which may be applied to *sustainable innovation*.

It is anticipated that future conferences in the series will continue to make a valuable contribution to policy and practice in this vital aspect of sustainable development.

Numbers and content of presentations and papers

At the four *Sustainable Innovation* conferences (2003–2006), there were 61 invited speakers and 103 refereed papers as summarised in Table 1.1. In addition there were various less formal presentations and sessions, including, for example 'Living Laboratory' concepts presented in 2003 and various eco-creativity sessions in 2003, 2004 and 2005.

Table 1.1: Invited speakers and refereed papers

Date	Venue		Invited speakers	Refereed papers
2003	Stockholm, Sweden	(TSPD8)	14	39
2004	Farnham, UK	(TSPD9)	19	4
2005	Farnham, UK	(TSPD10)	14	30
2006	Chicago, US	(TSPD11)	14	30
Total			61	103
Grand total			**164**	

The subject and content of the presentations and papers was diverse, as illustrated in Table 1.2.

Table 1.2: Subject and content of presentations and papers

Subject/content	Total no.	Examples (paper no./year) – see Appendices (www.cfsd.org.uk/???)
New concepts and research into innovation	33	Sustainable Innovation Communities: The Role of Key Actor Networks in Promoting Sustainable Innovation (4/06)
Case studies on *sustainable innovation*/ product design by companies	32	Initiatives by Nike (24/05 and 16/06)
Eco/sustainable product design/ management research	29	SusProNet: a Key to Development of (Sustainable) Product-Services (44/03)
Policies for fostering *sustainable innovation*	24	Reports on UNEP's activities in sustainable consumption and production (9/03, 6/04 and 36/05)
Business sustainability/new business models	10 10	The Business Case for Sustainability: Convincing Skeptical Executives (44/05)
New tools	10	The Biomimicry Portal: A Tool for Sustainable Innovation (9/06)
Broad design concepts and discussion	9	Sustainable Solutions In A Network Society: Social Innovation, Creative Communities and Advanced Industrialisation (25/05)
Social and ethical issues	7	Fairsource: An Alternative Business Model for Offshore Outsourcing (9/04)

Note: Numbers are approximate since many presentations could fit several categories

These categories of presentation/paper are summarised as follows:

- Presenting new concepts and research in specific areas related to *sustainable innovation* and eco-innovation has been a central aim of the conferences and also, by numbers, one of the main subject areas for presentations and papers (33 in total). Within this broad subject area a diverse range of topics have been covered, including processes at the level of the firm and at the level of markets and society.
- Another key focus has been presenting best practice, and a similar number of presentations and case studies (32) have illustrated experience by companies. In some instances these have been presented by companies and in other cases by researchers. One of the leaders in the field of *sustainable innovation*, InterfaceFlor, presented its innovation management processes on three occasions and another leader, Nike, presented twice. Cases on other major companies have included ABB, Boots, DAF, Fujitsu Siemens, GE, Hartmann, Herman Miller, Lucent, Philips, Procter & Gamble, SC Johnson, Sun Microsystems and Toyota. These covered eco-design application and management as well as innovation management.
- Closely related to research in the broader area of *sustainable innovation* is work in the specific area of eco-design and sustainable product design and development (SPDD) [see Definitions – Section 2 – for the distinctions]. This has also been a key subject area (29 papers) covering design processes and management and consideration of new approaches to sustainability such as Product-Service Systems (PSS) (itself the subject of 8 papers).

- Policies for promoting *sustainable innovation* was an important subject area (24 papers), including presentations on policy initiatives at international and government level, policy research and discussion of policy needs.
- Providing the business context for *sustainable innovation* including discussion on business sustainability and new business models (10 papers).
- Overlapping with conceptual research was the presentation of new tools for sustainable innovation and design (10 papers).
- Broad design concepts and discussion covered a range of general subjects relating to the role of design and innovation in SCP (9 papers).
- The majority of papers related to environmental issues. However, 7 papers specifically addressed social, ethical and corporate (social) responsibility (C(S)R) issues including ethical sourcing and design for the 'bottom of the pyramid', a term referring to the poor majority of the world whose needs must be addressed for moral reasons as well as to secure a sustainable future for the world as a whole. If C(S)R initiatives within company case studies are included, then the role of this subject in the conferences is significantly increased.

Structure and content of this booklet

The key conclusions from the 2003–2006 *Sustainable Innovation* conferences are summarised in the main text of this booklet, while lists of presentations and papers for each year are provided in Appendices 1–4. The presentations and papers from each conference with notes on the content and conclusions can be downloaded from **www.cfsd.org.uk/si03_si06**. The copies of past conference abstracts and proceedings should be referred to for further details.

Although each conference has had a main theme, many of the issues discussed have been ongoing, recurring or reinforced in subsequent years. The conclusions are therefore presented by subject but referenced by year and paper where an issue or example is highlighted. In this booklet, therefore, conclusions are grouped under the following headings:

- Definition and importance of *sustainable innovation*
- Drivers
- State of the art and application
- Obstacles
- Policy needs
- Needs for implementation in business
- Needs for collaboration in developing *Sustainable Innovation Systems (SIS)*
- Needs for further research and understanding.

Throughout the booklet, although ill-defined *sustainable innovation* is used as a shorthand to denote both broader sustainability-driven innovation and environmentally-driven innovation (eco-innovation). Unless otherwise stated *sustainable innovation* is also used in the context of the creation and development of technologies, products and services. In some instances, eco-innovation is specifically referred to.

2 Definition and importance of *sustainable innovation*

A continuing issue raised at the conferences is that there is no established definition for *sustainable innovation. Sustainable innovation* is nevertheless a critical dimension of sustainable development (SD) and strategies for achieving sustainable consumption and production (SCP).

Innovation

Innovation is the successful exploitation and commercialisation of new ideas. It is far more than the common perception that innovation is only about new ideas or research and development (R&D). Innovation can:

- Cover all processes, technological, organisational and marketing, in the development and commercialisation of novel products and services providing value to customers
- Occur at four main tiers or levels
  - technologies/products/services
  - process
  - organisational
  - business
- Include, but is not restricted to the ideas and research stages of the innovation cycle, or to novel technology alone, although these are core elements of innovation
- Include 'low tech' and is not restricted to 'high tech' technologies.

Sustainable innovation and eco-innovation

There is no precise or established definition for *sustainable innovation*, reflecting the more general difficulty in defining the concepts of sustainability and sustainable development.

Arthur D. Little (2004) defined 'sustainability-driven' innovation (2/04) as *'the creation of new market space, products and services or processes driven by social, environmental or sustainability issues.'*

As with general innovation, there is an emerging recognition that *sustainable innovation* is not just about new concepts but is about commercialisation of technologies, products and services and about entrepreneurship. It can also be about the adoption of new processes and systems at societal level.

> *Sustainable innovation is a process where sustainability considerations (environmental, social, financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialisation. This applies to products, services and technologies, as well as new business and organisation models* (Charter, 2007).

The term *sustainable innovation* is used throughout this booklet for consistency with the name and scope of the conferences, which have sought to address the social and ethical as well as environmental and financial dimensions of sustainability. An alternative and equivalent term is eco-innovation.

Eco-innovation has been described as:

> *The process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact* (James, 1997).
>
> *Eco-innovation is any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy.* Source: Competitiveness and Innovation Framework (2007 to 2013).
>
> *Eco-innovation is the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for all, with a life-cycle minimal use of natural resources (materials including energy, and surface area) per unit output,*

and a minimal release of toxic substances. Eco-industry includes businesses across all sectors that are pro-actively and demonstrably involved in eco-innovation, including novel solutions to satisfy legally set standards, norms and requirements. Source: Europa INNOVA Thematic Workshop, Lead Markets and Innovation, 29-30th June 2006, Munich, Germany.

Although the two terms are often used interchangeably, eco-innovation only addresses environmental and economic dimensions while *sustainable innovation* embraces these as well as the broader social and ethical dimensions.

Social and ethical issues are especially relevant to sustainable product design and development (SPDD) in the areas of outsourcing and in specific 'bottom of the pyramid' products aimed at meeting the needs of the world's poor. In general, however, these issues are not easy to apply directly in the fields of product/service design and innovation. Finding solutions to environmental problems through eco-innovation has been, and is likely to remain, the primary focus for *sustainable innovation* while aiming to achieve social benefits. These factors have been reflected in the content of conference papers and discussion which have been mostly about eco-innovation.

Levels of *sustainable innovation*

Both *sustainable innovation* and eco-innovation have been defined as covering the spectrum of levels of innovation from incremental to radical. Whilst there are no absolute or quantifiable definitions and boundaries, four main levels of innovation can be defined in the context of environmental improvement. The below is adapted from Stevels, 1997.

- Level 1 (incremental): Incremental or small, progressive improvements to existing products
- Level 2 (re-design or 'green limits'): Major re-design of existing products (but limited the level of improvement that is technically feasible)
- Level 3 (functional or 'product alternatives'): New product or service concepts to satisfy the same functional need e.g. teleconferencing as an alternative to travel
- Level 4 (systems): Design for a sustainable society.

The primary focus and aim of *sustainable innovation* is on higher levels of innovation which may contribute to significant or 'Factor X' reductions in environmental impacts.

The need for radical innovation is illustrated by the I =PxAxT (or IPAT) equation (Ehrlich and Holdren 1972) where I is the environmental impact of a population 'P' consuming at a level 'A' per capita (representing affluence) and employing technology 'T'. Globally 'P' may double over the next 50–100 years but 'A' could increase many times more in line with the compounded growth of the world's economy as living standards rise for many, both rich and poor. Estimates vary in how much PxA may increase but comparable reductions in the 'T' factor through new technology will be needed to offset the PxA increase. The equation also indicates the need to constrain the PxA increase through societal change and reduction of consumption.

In practice radical technological innovation of any type has been rare and tends to occur mainly in times of crisis such as war when economic, market and other considerations are suspended. The same applies to higher levels of eco-innovation which has so far been mainly at lower levels.

Paper 36/06 discusses the dynamics of technology and innovation for sustainability in the context of the rhetoric of 'technological revolution' as the solution to environmental sustainability.

Sustainable innovation and sustainable product development and design (SPDD)

There are various areas of overlap between innovation and product design and development and, in the present context, between *sustainable innovation* and SPDD.

Innovation, as noted above, includes all processes and stages in the commercialisation of new products, services or processes, including such innovation-specific processes as research and development (R&D) and technology/knowledge transfer. Design is concerned with specific processes relating to planning, design and development, especially at the pilot or pre-production stages of the innovation cycle. Design is therefore an aspect of the broader concept of innovation.

Corresponding considerations apply to *sustainable innovation* and SPDD, the systematic incorporation of life-cycle sustainability/environmental considerations into product/service design.

Reflecting the areas of overlap, SPDD or eco-design has been the subject of many of the papers in the *Sustainable Innovation* conferences as noted in Table 1.2 above.

Recognised importance of *sustainable innovation* for sustainable development

The above discussion of the need for 'Factor X' reductions in environmental impacts through technology highlights the importance of *sustainable innovation* in the transformation towards more sustainable patterns of consumption and production, and towards sustainable development.

The importance of *sustainable innovation* in these broad contexts has been recognised since the sustainable development debate emerged in the 1980s and was reinforced since the 1990s by United Nations (UN), European Commission (EC) and other national initiatives. *Sustainable innovation* has, however, remained mainly peripheral outside of such initiatives and a few more advanced countries and companies. The company case studies presented here (e.g. by InterfaceFlor – Section 1 above) are not typical of business as a whole.

The subject is now, however rapidly moving centre stage in response to growing concerns about climate change, resource depletion and other problems in meeting the needs and aspirations of a growing world population. There is also increasing recognition of the economic opportunities in growing global markets for sustainable technologies.

Developments during the period covered by this booklet have included, for example:

- United Nation Environment Programme (UNEP)'s ongoing initiatives and programmes covering SCP, of which eco-innovation plays a key role. UNEP representatives have presented updates at the *Sustainable Innovation* conferences (see 9/03, 6/04 and 36/05)
- The European Stakeholder Meeting on SCP (Ostend, Belgium, 25–26 November 2004) co-hosted by EC and UNEP included a working group on the 'role of innovation'
- Conference on eco-innovation hosted by the European Environment Agency 19–20 April 2005
- Speech to the European Business Summit on the eco-innovation challenges for European business. Given by the European Commissioner for the Environment (March 2006)
- Launch of the EC Innova project to promote eco-innovation (2006)
- The development of Environmental Technology Action Plans (ETAPs) by the EC and all Member States (2006). Supporting eco-innovation features strongly in these as well as broader sustainable development plans and strategies.

3 Drivers

The conferences highlighted the existing and emerging drivers for *sustainable innovation*.

These drivers have, until recently, generally been weak but the picture appears to be changing as a result of mounting global environmental and sustainability problems. Key drivers include the following:

- **Environmental and resource risks**: Concerns in these areas (Table 2) are generating demands for solutions. Climate change has moved from being a peripheral issue for government, business and society to taking centre stage. It was fitting that the keynote address for the 2006 Chicago conference was by the Chicago Climate Exchange (15/06).

The rise in oil prices resulting from growing global demand is increasing prices for petroleum-based materials and is in turn driving a search for more sustainable alternatives and substitutes. The development of new sustainable materials is a key enabling factor for SPDD e.g. Fujitsu launched a laptop in 2004/5 using a bio-based resin, polylactide (PLA). The use of biomaterials provides a mechanism to contribute to the reduction of greenhouse gas emissions and support 'closed loop' manufacturing systems.

Table 2: Key environmental and resource issues

These represent the core drivers and include the following:

- Increasing consumption of energy and materials associated with a growing global population especially in China and India
- Climate change has now become a concern for a variety of stakeholders
- Increasing costs of petroleum dependency: besides climate change these include potential economic and social destabilisation, and military tension and conflict
- Water shortages are becoming a global concern with increasing demand and potential drought resulting from climate change
- Pollution and loss of biodiversity.

- **Sustainable Consumption and Production (SCP) policies**: Policies aimed at achieving SCP are an increasingly important driver for *sustainable innovation* and are emerging at national and international levels.

Table 3.1: Examples of SCP policies

- The Marrakech process appears to be broadening the discussion and is progressing at the international level with the United Nations Environment Programme (UNEP) now setting its SCP priorities: industrial development; waste management including 3Rs (reduce, re-use, recycle); SCP training and capacity building; sustainable trade and resource consumption; and sustainable energy and mobility.
- At the SCP meeting in Costa Rica in 2005 further progress was made with various countries agreeing to make contributions to the process through leading working groups: Sweden on sustainable lifestyles, advertising and youth; Germany on co-operation with Africa e.g. leap-frogging; UK on sustainable product policies; Switzerland on sustainable procurement; Finland on building and construction; and France on tourism.

- The proactive involvement of the UK in building the 'evidence base' for SCP and particularly in the international product debates indicates a shift of emphasis of UK government – reinforcing the importance of SCP and products as highlighted in the UK Sustainable Development Strategy (SDS) launched in March 2005.
- The UK SDS launched on 7 March 2005 highlighted a range of issues related to sustainable products, services, technologies, design and innovation.
- The sustainable consumption element of the SCP discussion is still relatively new but emerging especially around issues such as green or sustainable public procurement as a stimulus for eco-innovation. For example the UK Government's report 'Procuring the Future' (the Simms Report, June 2006) and its stated target of being a leader in the field by 2009 highlighted the growing interest by the UK government in sustainable procurement.

- **Product environmental regulation and other product policy initiatives**: There are various existing or proposed measures or initiatives, including regulation and voluntary agreements, which may help to stimulate *sustainable innovation*.

Table 3.2: Emerging product environmental legislation

- The Energy using Products (EuP) Directive promises to have a major global impact on the supply chains (or networks) of energy-using-products when the implementing measures are put in place in July 2007.
- Integrated Product Policy (IPP) thinking may increasingly be seen to be part of the European SCP policy debate, through promoting a smarter mix of demand and supply-side (product) policy tools to reduce global lifecycle impacts.
- The EC's Environmental Impact of Products (EIPRO) study identified four sectors as being the worst performers from a lifecycle perspective: food; drink; housing; and transport. We may see in the future much more focused product policy to reduce the environmental impact in these sectors.

Financial and market drivers

Although not always clear or strong, or translated into significant innovation, financial and market drivers are emerging as existing or potential major drivers. In some cases they are emerging as part of the conditions of doing business and in others they are competitive issues.

Table 3.3: Product and market drivers

- As noted above, pressures for material and energy cost savings are driving dematerialisation and material substitution. This applies to all markets for business reasons.
- In some markets, *green* elements have become mainstream e.g. vehicles (see DAF case 37/03).
- In some markets there seems to be a trend towards *green* just being seen as an integral part of a good brand/product/company – and if the company gets it wrong (e.g. it is found using child

labour in outsourced factories) this may result in 'brand-switching', loss of business and customer loyalty (see Nike cases 24/5 and 16/6).

- There are indications that customers in some markets are increasingly expecting responsible products/brands from responsible companies – therefore the development of sustainable and responsible business models is likely to become more and more of an issue (see papers and discussion in 2004).
- Although a small part of total investment, socially responsible investment (SRI) is having an increasing influence on the behaviour of corporations (see 16/04: Sustainable Innovation: A Viewpoint from the Investment Community).
- Protecting brands and reputation are becoming increasingly important risk issues for companies (Nike case above).
- Potential customers are perceived by companies to be key drivers for *sustainable innovation* and, from discussions, companies fear a lack of market readiness for *sustainable innovation*.

Wider sustainability issues

Pressing sustainable development problems increasingly need solutions from business:

Table 3.4: Sustainability issues

- The role of the transnational in the global society is increasing being questioned. There are 3 billion people who live on less than $2 per day. (Millennium Development goal 1: Eradicate extreme poverty and hunger).
- Global business has a potentially crucial role in developing sustainable solutions to solve these problems.
- Meeting needs sustainably may help address, mitigate or avoid social problems and the consequences of growing gaps between rich and poor.
- North:south trade issues. Companies in developing countries lack accurate and timely information in relation to potential emerging business opportunities and threats in the North – how can this situation be improved?

Work in this area by Cornell University (39/06) highlighted the challenges and opportunities.

Social and ethical

There are emerging concerns around corporate (social) responsibility (C(S)R) and accountability. So far, C(S)R has tended to focus on management issues – but there may be a growing discussion around the morality of products and services e.g. particularly over human dimensions and social issues associated with the manufacture of products and the delivery of services in, for example, China and India. Therefore, with many supply chains (or networks) stretching around the globe there could be increasing discussion over 'lifecycles of responsibility'. What this means for public policy and companies still needs to be more clearly defined.

Various conference papers presented cases and research linking SPDD to C(S)R (e.g. 9/05).

4 ‘State of the art’ and application

Sustainable innovation is a new and developing field. There are still relatively few examples of sustainable products and services achieving major market penetration. Examples of application have been presented in the *Sustainable Innovation* conferences as case studies but these have been mainly by a few leading companies, are pilot or niche products or represent incremental improvements to existing products. *Sustainable innovation* is not yet applied as a mainstream practice and rarely at the radical level required (see discussion in ‘Definitions’, Section 2 above) for the transformation to SCP and SD.

General state of the art

As discussed in Section 2, *sustainable innovation* can include various levels. There is a pressing need for higher levels but, in practice, most application is at lower, mainly incremental levels and across business as a whole, application is frequently non-existent.

There are various reasons for this summarised in Table 4.1 and discussed under Obstacles (Section 5) but in general it is difficult for business to proceed beyond incremental levels without major market and societal changes which have yet to occur.

New concepts and techniques are nevertheless emerging and many of the conference papers have presented these, for example developments in Product-Service Systems (PSS) as a strategy for reducing material impacts (e.g. 44/03).

General application by companies

Various cases presented in the *Sustainable Innovation* conferences (see Table 4.2 for examples) demonstrate the feasibility and benefits of *sustainable innovation* and of applying sustainability concepts to product development and design. These, illustrate practice by leaders but, by definition, are not typical (see Section 1 for main companies).

Many conference papers and discussions highlight the broader picture on application as summarised in Table 4.1.

Table 4.1: General levels of application

Mostly incremental environmental improvement

- The current paradigm of sustainability is focused on environmental aspects and on incremental change and/or re-design rather than on more radical levels of innovation.
- Most examples are incremental, re-design, ‘one-offs’ or niche market offerings.
- Few companies have started to incorporate sustainability into the creativity phase of new product/service and business development processes and there is still relatively little *sustainable innovation* (technologies/products/services) being implemented on an on-going basis (see Obstacles Section 5).

Product designers mostly new to sustainable innovation

- Product designers are still new to sustainability but some are starting to recognise the opportunities to ‘add value’.

Eco-design stagnating in some countries and companies, growing in others

- Eco-design is stagnating in some countries whereas in others, programmes are just being established (**www.cfsd.org.uk/aede**). It may be that in some cases 'green limits' have been achieved in re-designing existing products (see levels of innovation in Section 2 and also 37/05).
- Several Northern European countries developed eco-design programmes in the mid-nineties (see ESTO studies on **www.cfsd.org.uk/research**) and are now not investing at the same level e.g. the Netherlands. Japan, however, seems to be continuing to encourage more systematic implementation of eco-design (26/05).
- Some transnational companies have been working on eco-design for well over a decade and are now starting to experience technical and functional limits to the eco-innovation of their products – with the focus now shifting to other areas e.g. value chains and social considerations (see 37/05 for the case of Philips).

Social and wider sustainability issues emerging

- The social dimension of *sustainable innovation* is starting to emerge but is a new area even for leading-edge companies.
- Integrated SPDD is in its early stages of development, however companies like Boots (20/05) are starting to explore the 'triple bottom line' concept in relation to products as a result of growing consumer pressures.

Developments in Japan (26/05 and 33/03)

- Japanese companies are progressively implementing eco-design programmes and this appears to be part of broader plan that has been agreed between industry and government.
- Japan's commitment to the implementation of eco-design is an international competitive issue.
- The Japanese eco-design approach is based on its technological strengths and is now becoming a prerequisite for companies particularly in electronics, white goods and automotive.
- Part of the framework change has been through a mix of voluntary agreements, legislation e.g. the implementation of the Green Purchasing Law (GPL) in 2001, and the organisation of 'The Eco Products Expo' in Tokyo (every December since 1999) as an information instrument to raise awareness of eco-products. In 2005–6, similar exhibitions were also organised in Thailand, Singapore, Korea and China.
- In 2005, Japan chaired the newly launched International Green Purchasing Network (IGPN) that appears to be based on Japan's own Green Purchasing Network (GPN) originally established in 1996.

Availability and application of tools and methodologies

- A range of eco-design and SPDD methodologies have emerged over the last decade e.g. McDonough Braungart Design Chemistry (MBDC) 'cradle to cradle' protocol (see 2/05) – however there is no common approach, methodology or viewpoint
- Various companies, for example InterfaceFlor (3/06), are starting to experiment with mechanisms to stimulate *sustainable innovation* e.g. development of an external advisory board, workshops, etc
- Leading companies are developing their own in-house product-related environmental evaluation procedures and customised tools.

Table 4.2: Examples of cases presented

InterfaceFlor (3/06)

InterfaceFlor has a sustainability vision driven from the top and this is now supplemented by growing customer and competitive pressures. In Europe, the firm has experimented with approaches to *sustainable innovation* but continues to face a range of internal and external challenges in trying to move the agenda forward. In 2003, the company decided to create an external expert network to help generate new ideas from outside the firm e.g. open *sustainable innovation*.

Nike (24/5 and 16/06)

Central to Nike's approach to sustainability is its internal tool – the 'Footwear Sustainability Index (FSI)'. The tool has gained legitimacy by linking job performance to achievement of its associated objectives. This approach is a key to developing awareness, and a shared system and language. To nurture and grow *sustainable innovation* requires a supportive organisational culture with a bias to openness to radical ideas, experimentation, action and learning. Nike developed a customer-focused project named *Considered* which has delivered a range of benefits including new thinking, product innovation, as well as indirect production innovation. As a result of the success of *Considered*, Nike is presently considering how to integrate sustainability into its design process and develop a new system and language around SPDD. The companies' experience also highlights that changes related to SPDD require supply chain innovation.

Lucent (29/05)

Lucent's customers are focusing on environmental requirements and increasingly interested in product-specific aspects. As a result, Lucent has developed a product-based environmental management system (PBEMS) that is entirely consistent with ISOTR14062. The company has received ISO14001 certification for its product realisation process – this has created an important bridge between product development and environmental management systems. The PBEMS has been developed because location-specific environmental impacts are increasingly less important as a result of the changing business model. Ownership of eco-design has now moved from Environmental Health and Safety (EHS) to Product Design and Development (PDD) with a shift to full integration. To enable this, collaboration with a broader range of business functions is starting, using web-based awareness devices and personal networks. Lucent's design engineers use guidelines, checklists, web-based tools and an in-house 'OneDFE' process is undertaken on new products with use of an in-house Lifecycle Assessment (LCA) methodology – consistent with ISO14040 – to evaluate products in more depth (where necessary). In addition, a specific energy-modelling tool is used to help customers evaluate energy impacts of new/existing systems in use (also identifying cost reduction opportunities). One of the key goals is to use eco-design to reduce over-designed products that are expensive to manufacture (for Lucent) and operate (for the client).

Boots (20/05)

Boots focus on six areas in relation to its sustainability activities: biodiversity; chemicals; energy; sustainable products; transport; waste and recycling. The company aim to integrate sustainability into product development – linking innovation to sustainable products. They use various checks and balances in the product development process – with the 1st stage being risk assessment that includes sustainability criteria. If risks associated with a new concept are identified as being greater than a certain point then a sustainable product assessment tool is used. LCA may also be used if greater depth of analysis is required. Central to the Boots process has been the building and use of its knowledge management system called 'Product Bank'. In addition, Boots has started to identify social considerations in product development.

Herman Miller (2/05)

Herman Miller – a furniture manufacturer – use the McDonough Braungart Design Chemistry (MBDC) 'cradle to cradle' SPDD philosophy focused on: materials chemistry, disassembly and recyclability. As with other companies, Herman Miller has found that a key issue is the need to work closely with suppliers, especially on materials issues.

New concepts and business models

Various papers illustrated how new concepts and techniques may be applied to fostering *sustainable innovation* at a systems level or in companies.

At a systems level, approaches to understanding and achieving SCP are of fundamental importance. Understanding consumer behaviour is a continuing area of research.

Developing sustainable (new) business models is a increasing area of discussion in the *sustainable innovation* debate. In a globalised world new business models are emerging regardless of sustainability considerations and these will need to increasingly take account of associated adverse environmental and social impacts e.g. through outsourcing (9/04).

Sustainable solutions to sustainable development problems will also require sustainability-oriented business models, e.g. sustainable Product-Service-Systems (PSS) designed to satisfy functional needs through lower or non-material services rather than through physical products.

Experience and analysis of PSS (see **www.suspronet.org** and 44/03) and including experiences from papers presented in the conferences, illustrate that there are no simple solutions to sustainability problems. Substituting services for products is not in itself a solution since services do not necessarily have a lower environmental impact than products – many services also include a material product component.

Table 4.3: New business models

New business models – general

Developing sustainable (new) business models is a new area of discussion in the *sustainable innovation* debate and companies need to consider opportunities. The conference discussions identified perhaps three current levels of debate:

- Organisation structures: the impact of sustainability on changing business models e.g. 'hollow companies' that exist only as brands, with manufacturing and other business functions
- New approaches: new business models that aim to reduce environmental impacts e.g. Electrolux's washing solution based on paying for the use of the service
- 'Bottom of the pyramid': new products and business concepts based on providing solutions for the poor in the developing world.

Product-Service Systems (PSS)

PSS is an interesting new approach to business development that may help create more sustainable solutions (see **www.suspronet.org**) as this enables companies to explore the 'bigger picture' or 'whole system' – thus broadening and developing more holistic thinking.

- Businesses do not use PSS terminology and see it as an academic definition for something that they are already doing! Many companies are developing and implementing PSS as part of 'value-added' thinking – but from a business and not a sustainability perspective.
- In many firms it appears that PSS development may not be as integrated, systematic and structured as it could be e.g. those responsible for the development of product component of a PSS often act separately from those responsible for the implementation of the service component of a solution.
- PSSs are not necessarily more sustainable as much depends on the 'system design' and impacts are very case dependant. Designing a 'unique system' can also help protect against copying – but if one component of the system does not function then the system may collapse – financially, socially and/or environmentally.
- Thinking in PSS terms will often mean focusing more closely on customer needs and relationships which can lead to improved loyalty and greater probability of repeat purchase. Moving in this direction will require a cultural shift from 'product-orientation' to 'service-orientation' – which will mean a change in mindsets amongst various business functions in organisations e.g. from salesmen selling outright purchase of units to selling cashflow over time.
- Opportunities for more sustainable PSS are likely to be industry/need specific but at present there are a lack of successful sustainability-driven cases to learn from
- PSS has a range of benefits but its real strength is that it helps companies to focus on the final need, demand or function and can create novel concepts for more sustainable solutions.

5 Obstacles

A central theme arising from conference papers and discussions was the obstacles to *sustainable innovation*. Most of the presentations proposed solutions to general obstacles. Identifying and understanding barriers or obstacles was the specific aim and focus of some papers.

Obstacles exist at various levels. Categorising them is useful in developing strategies and approaches to addressing them. No order of priority is intended here – all are significant and related, and need to be addressed in an integrated way.

Innovation of any kind is an inherently difficult and complex area while *sustainable innovation* presents its own problems.

Dutch research (33/05) identified the main barriers to eco-innovation as:

- The market: there is an opportunity for sustainable public procurement and public sector prescriptions such as 'use hydrogen buses' to drive eco-innovations
- A lack of capital e.g. venture capital, the Dutch have developed a Green Fund Scheme to proactively stimulate investment
- The business climate: information flows need to be better managed and improved networks need to be built e.g. between scientists, entrepreneurs, large companies and others *(Sustainable Innovation Systems (SIS))*.

The main obstacles are outlined here, recognising there have been increasing signs of them begin to weaken.

System, physical and situational

Sustainable innovation at a system level is only likely to occur if there are strong triggers and drivers to overcome powerful inertia and other obstacles in existing economic, social and other systems, and the technology is available to effect change.

The IPAT equation (Section 2) suggests that radical, stepwise or breakthrough beneficial technologies need to be developed at a rate of population x economic growth simply to offset increased environmental impacts. Presently, the situation is not favourable, especially considering the long lead times for the development and application of radical innovation (36/06).

Table 5.1: System level obstacles

Lack of strong triggers and drivers for system change

- Historically, radical innovation has been rare and driven by major events (e.g. wars) or out of necessity arising from other changes in the world (e.g. disasters).
- In the environmental and sustainability area there have been some triggers and events raising consciousness and creating some change in regulation and business, but there is little evidence of long-term changes in behaviour.
- There has been a lack of system change and this has resulted in the development of *green* niches rather than significant shifts in the marketplace.

System inertia and physical

Fundamental problems are still hard-wired into most western economies which are geared to 'business as usual'.

- Waste and other environmental impacts are often 'designed into' the system.
- Much existing infrastructure is inherently material and energy-inefficient and cannot be replaced overnight. Unlike some emerging economies, opportunities for leap-frog developments are generally limited in developed economies.

Technological

- There remains a lack of 'breakthrough' technologies which might provide vehicles for higher levels of *sustainable innovation*.

Market

Market drivers for *sustainable innovation* have been generally weak, although the situation may be changing rapidly, at least with respect to some aspects e.g. the growing recognition of climate change is starting to drive innovation in low carbon technologies. Some key opinion-formers are suggesting that there are 10 years to make the changes that are needed if we are not to pass the 'place of no return'. This is a major opportunity for innovation.

Table 5.2: Market obstacles

Lack of market awareness

- There is a wide variation of awareness of sustainability/environmental issues in 'business to consumer' (B2C), 'business to business' (B2B) and 'business to government' (B2G) markets worldwide.
- B2C customers tend to be particularly wedded to the ownership of products and in some segments to over-consumption, as exemplified by the obesity epidemic in many countries.
- There is a major gap between what B2C consumers say in surveys about their intention to buy sustainable and/or greener products and what they actually do buy in practice – the so-called 'action:awareness' gap.
- However, there are indications that retailers e.g. Walmart and Tesco are starting to drive eco-innovation amongst suppliers.

Lack of market incentives

- In the majority of cases, markets are still dominated by price with markets still being niche markets.

Financial

By its nature, innovation is a high risk activity which needs financial support during the often long lead time from R&D to commercialisation. Although the situation is changing, there has generally been a lack of interest from the financial community. However, this changing in California (US) with a significant growth of venture capital and business angel money now moving into 'cleantech'.

The difficulties of financing eco-innovation have been recognised at EC and national government levels, and there are emerging initiatives to address the problem. For example in 2006 the EC and UK government hosted conferences on the issue.

As noted above, Dutch research noted lack of capital as the main obstacle next to lack of markets. However, some are suggesting that it is not the lack of finance that is the biggest barriers to eco-innovation, it is the lack of good business plans amongst 'start-ups'. Again, there indications in California (US) that a number of experienced and serial entrepreneurs are now moving into the 'cleantech' space to move technological R&D and inventions into commercialisation.

Table 5.3: Financial obstacles

Lack of venture and seed capital

- Lack of venture capital is a perennial problem, especially for small and medium sized enterprises (SMEs) and entrepreneurs in all industries, but this has been a particular problem in the area of *sustainable innovation* because of weak markets and other issues
- There is also a lack of start-up funding for sustainable technologies/products/services.

Limited interest by financial markets

- The investment community has generally not been engaged in the discussion due to: business concepts/technologies often being seen as too risky; financial returns not being seen as significant enough to justify investment; and there being not enough successful entrepreneurs with track-records in the area.
- Sustainability has often been perceived by the investment community as a soft issue e.g. not a serious business issue.
- Socially responsible investment (SRI) is growing but still a small part of total markets, dominated by the system that has to deliver short-term, quarterly results to shareholders amongst publicly owned companies. This limits decision-making freedom and willingness to take risks in the area of *sustainable innovation*.

Indications of change

- Concern over climate change, retailer pressures and other issues are leading some investors to start investing in cleantech – as evidenced by the 'cleantech' boom in the US.

Policy and regulatory obstacles

In the absence of strong market and financial drivers, policy and regulation are critical for stimulating *sustainable innovation*. Some drivers are emerging as noted above but policy developments are immature in this area. A number of papers referenced the inadequate response in relation to the problems. Peattie (31/05) discussed the tendency of governments to manoeuvre rather than adopt strategic responses.

Table 5.4: Policy obstacles

Gaps

- Most developments are new and yet to impact on markets to stimulate *sustainable innovation*.

Uncertainty

- Business perceives there to be too much change, which creates increased risk for investment – there is a need for environmental policies that are consistent, flexible and future-oriented.

Lack of coordination

- The implementation of *environmental* product policy varies considerably throughout Europe and instruments used by Member States (MS) seem to lack coherence and coordination with different policy tools applied by different ministries in different ways in different countries.
- In addition, different MS have different policy emphases with information instruments still predominantly used. A more strategic, coordinated and smarter use of demand and supply-side (product) policy tools still seems to be an imperative if global lifecycle impacts are to be reduced. However, approaches will need to acknowledge that many impacts on the supply-side e.g. manufacturing are interesting moving to South and South-East Asia.
- A weakness in existing EC Integrated Product Policy (IPP) discussions has been the lack of measurable concrete cases and little consideration of services and product-service combinations which are now an integral part of many solutions.
- Work by the EC on IPP may merge into new policy developments on SCP.

Decision-making systems

Innovation requires the engagement of a variety of players in *Sustainable Innovation Systems*, including inventors, entrepreneurs, investors, R&D, etc. Obstacles have been identified within system structures and links.

Table 5.5: Obstacles in system structures

Lack of links between players

- There is a lack of strategic engagement with key role players – who move in and out of discussions over time – resulting in ad hoc and minor changes.
- Poor linkages exist between sustainability/environmental experts, investment community, entrepreneurs, R&D, and inventors – which means that *sustainable innovation* opportunities are being missed.
- A lack of catalysts for *sustainable innovation* means that relevant stakeholders are not being brought together e.g. the 'dots are not being joined-up'.

Fragmentation of influence and decision-making

- As indicated above, design and manufacturing are now geographically distributed worldwide. This means that there is often a limited ability to influence the environmental performance of some products. For example, in the case of mobile phones, component manufacturers – rather than product manufacturers – are in a powerful position to create environmental improvements but are unlikely to do so unless there are financial or other benefits to them.

Organisational

Obstacles have been identified within organisations at various levels, from lack of senior level commitment to lack of implementation capability. One of the weaker areas of understanding is around organisational dimensions of *sustainable innovation*.

Table 5.6: Organisational obstacles

Lack of senior level vision and commitment

- Outside of leadership companies, senior level vision and commitment to sustainability in government and companies is lacking, and therefore there is still little commitment to *sustainable innovation*.
- Sustainability is still seen as a threat-based agenda rather than an area of business opportunity. This means that sustainability is rarely considered in corporate strategy, business development and/or the 'opportunity search' process within firms.
- This translates into a lack of awareness and understanding of sustainability/environmental issues amongst key business functions e.g. finance, marketing and R&D (e.g. if you are not aware of the issues, you don't see the opportunities!).
- Some leading companies have taken the initiative but there has been a limited uptake of *sustainable innovation*, SPDD or eco-design outside of large companies/transnationals or niche players.

Organisational structures

- Old style, rigid companies are unlikely to create radical supply-side innovations to move us towards sustainability.
- Organisational systems and procedures in firms are often inflexible which means that the integration of sustainability/environmental considerations into the technology/product/service development processes requires commitment and sustained effort to enable this to happen on a day-to-day basis.
- As a result, many large companies/transnationals are not seeing the emerging opportunities or are nervous about taking a pioneering or leadership role on *sustainable innovation* – for fear that things may backfire.
- Short-term delivery pressures and responsibilities mean that there is often a lack of time and space to explore *sustainable innovation*.

Organisational capabilities

- Many eco-entrepreneurs lack sound business plans and clear business models
- In addition, the commercialisation process needs to be improved e.g. existing 'start up' sustainable technology/product/service inventors/developers often lack business and marketing skills.
- Awareness and understanding of the sustainability and *sustainable innovation* and how to apply it is generally weak at present (see below).
- SMEs globally lack awareness and understanding of *sustainable innovation*, SPDD, eco-design approaches and techniques.

Lack of engagement of marketing and other functions

- Marketing has a potential pivotal role to play in the *sustainable innovation* debate as they sit at the interface of consumption and production decisions in the firm. But, generally there is a weak interaction between Marketing and Sustainability/Environmental/C(S)R professionals and a poor understanding of each other's respective roles and challenges.
- The relationship or lack of relationship between Marketing/Sales and Sustainability/ Environmental/C(S)R professionals is under-researched and given the number of people employed in the profession worldwide and their key role in SCP this seems to be a major gap in knowledge.
- Marketing's role in the product development/innovation process differs from company to company e.g. in some companies they are heavily involved, in others there is little engagement.
- In addition, Sustainability/Environmental/C(S)R managers are rarely engaged in the innovation process.
- A range of *green* product failures may have resulted from a lack of involvement of Marketing and marketing tools e.g. research, communications, etc – experience suggests that when *green* has been added to the product, marketing rule books often seem to have been torn up!
- More broadly within the marketing services industry – product designers and design consultancies lack understanding of sustainability/environmental issues due to a) lack of sustainability/environmental education and b) lack of client demand. This has led to a lack of recognition of 'added value' opportunities associated with *sustainable innovation*.
- *Green* still often seems to suffer from a poor perception amongst B2C customers, product designers and marketing professionals – and the reasons for this need to be better understood.

Lack of understanding of implementation

- Lack of senior level understanding and commitment translates into a lack of understanding and knowledge over how to integrate sustainability into innovation policies in companies and governments.
- A changing business model further complicates things. Globalisation means that the value chains of technologies/products/services are increasingly geographically dispersed e.g. use (consumption) of the product maybe in Europe or the US but manufacturing (production) maybe in China, Mexico and Thailand. The implications of this for *sustainable innovation* are poorly understood.
- Companies perceive degrees of uncertainty associated with sustainability.
- At present *sustainable innovation* tends to be based on small, incremental changes and re-designs rather than on functional and system innovation. To achieve higher levels of *sustainable innovation* will require medium to long-term change in society.
- A focus on eco-efficiency and dematerialisation will continue to deliver lower levels of *sustainable innovation*.
- Most SMEs still have little awareness and understanding of the environmental and business benefits of eco-design and this will be a major problem when the Energy-Using-Products (EuP) Directive's 'implementing measures' come into force from 2007 onwards. SMEs have even less awareness of eco-innovation and less still of *sustainable innovation*.
- Experience suggests that SMEs have little motivation towards eco-innovation and *sustainable innovation* unless there are actual customer demands or immediate legislative pressures.
- SMEs generally have little awareness, understanding, knowledge and skills in relation to eco-innovation and *sustainable innovation* and what is needed are simple, practical and pragmatic tools to help them develop and implement solutions.

Conceptual and understanding

The concept of *sustainable innovation* presents conceptual difficulties which hamper solutions.

In only a small number of organisations with advanced sustainability missions, policies and strategies, and those large enough to impact on wider sustainable development, the term 'sustainable' remains a little understood and theoretical ideal rather than practical objective when applied to product development, design and innovation processes. S*ustainable innovation* can mean innovation in accordance with sustainability (social and economic as well as environmental principles), or it can mean innovation which contributes to the sustainable continuation of the organisation within society or the world as a whole. The former concept can be applied to product development, design and innovation but the latter does not lend itself to application by most organisations.

Table 5.7: Conceptual obstacles

Lack of clear definition

- As noted above, there is no common understanding of what *sustainable innovation* means. This relates to the lack of a popularly accepted definition of sustainable development which compounds the practical difficulties.

Lack of sustainability education, awareness and concern

- Awareness and concern regarding sustainability issues is relatively high among some governments, companies, social groups, and customer markets but remains low across most societies and markets. Demands for change are consequently still insufficient to strongly drive political, social and market change.
- Complacency, denial and 'islands of anti' continue to be prominent in many areas of government, business and society.
- The business case needs to be continually developed and communicated although this will become clearer as markets change and sustainability becomes a major competitive issue.

Lack of common language between theoreticians and business

- Innovation, sustainability and *sustainable innovation* are fields with a variety of concepts and terms which have not been adopted in most businesses and this reinforces communication barriers between business and academia.
- For example, as mentioned previously, PSSs are an interesting new approach to business development that may help create more sustainable solutions (see **www.suspronet.org**). However, businesses do not use PSS terminology and see it as an academic definition for something that they are already doing. Many companies are developing and implementing PSS as part of 'value-added' thinking – but from a business and not a sustainability perspective.

Lack of insight into solutions

- Sustainability is not an area with easy solutions, especially as we head into an increasingly uncertain future, and even experts have been better at analysing problems than formulating solutions.
- There are widely differing views on problems and solutions and often a tendency to make unjustified assumptions, oversimplify the issues or be over-optimistic regarding solutions and practical outcomes. This may contribute to continued debate and prevarication rather than

action, to misallocation of effort and resources, to sub-optimal results and to lost time when time appears to be fast running out to make a difference on issues such as climate change.

- Innovation of any kind, sustainable or otherwise, is an inherently difficult area with high failure rates. Radical innovations can take decades to become mainstream and it may be unrealistic to expect them to be adopted in the short to medium-term as some discussion appears to imply.
- The idea that technological innovation alone will inevitably achieve the transformation to sustainability is a common but questionably optimistic assumption when considering the IPAT equation (Section 2). Technology is only part of the solution (36/6) and shifting global consumption patterns will be a key challenge.
- Understanding of consumer behaviour remains limited beyond the conceptual or anecdotal level when considering the lack of consumer markets for sustainable products and services.

Lack of practical experience and information

There are few successful sustainability-driven models and cases to learn from.

Another complication is that the measuring of the sustainability performance of sustainable products and services and PSSs is complex due to a lack of good quality lifecycle data and information. This is further complicated by the nature of many PSSs e.g. they include a range of partners with their own value-chains feeding into the overall PSS. What is clear is that PSS does not always deliver sustainability benefits (44/03) but PSS thinking can create novel concepts for more sustainable solutions. Various examples were presented in the conferences e.g. surface treatment detergents based on renewable resources (50/03).

Lack of commercial edge

Many novel concepts and projects in this area have origins in the academic community. However results have often been disappointing in terms of:
a) lack of innovation e.g. they tended to focus on incremental change or eco(re)design
b) lack of a commercial edge; and
c) inability of presenters to sell their concepts.

This has illustrated and reinforced the issue that commercially-focused (sustainable) innovations do not tend to come from the academic community.

6 Policy needs

A continuing theme of the conferences has been the need for appropriate policies to stimulate *sustainable innovation*. Studies of successful environmental and other innovation suggest that there are many influencing factors but government policy and regulation can play a key role in stimulating innovation in the absence of strong market drivers.

The conferences have highlighted the existence of two domains: complexity and opportunity. Many of the issues arising from the SCP agenda are highly complex and require fundamental changes in the external framework. However, *sustainable innovation* – although ill-defined – is starting to emerge as a topic for discussion and opportunities are starting to emerge for proactive companies.

In the medium to longer-term many opportunities will arise and developments will take place in response to market demand regardless of government intervention. In the short-term, market intervention is likely to be needed in various areas to help stimulate *sustainable innovation*. There are a range of policy issues and needs associated with stimulating *sustainable innovation* at a macro and micro level. There needs to be better linking of these two strands in research, policy and implementation (36/06). As discussed in Section 4 and throughout the document, the current paradigm is focused on incremental change or re-design rather than on higher levels of innovation.

General policy needs

At the general level, public policy makers need to think through how to stimulate change, especially by addressing some of the barriers. To enable long-term change orientated towards to higher levels of *sustainable innovation* requires system level interventions that are hard-wired into public policy frameworks.

The following general needs were identified in policy-related papers and discussions.

Table 6.1: General policy needs

Clarification and bridges to policies for sustainable development

There is a fundamental need for governments to:

- Clarify what *sustainable innovation* means from a public policy perspective.
- Implement sustainable development and *sustainable innovation* policies – and to create bridges between the two to enable *sustainable innovation*.

Positive links to opportunities

- One of the key conclusions was that there needs to be a more positive link made in policy development e.g. *sustainable innovation* needs to be seen as an ‘zone of opportunity’ rather than just seen as better way to deal with environmental problems.

System level interventions

- System level interventions are needed as well as a focus on incremental change e.g. pollution per car unit has decreased, but worldwide car ownership and fuel consumption has grown hugely which means the ‘rebound effect’ is present.

Policy framework

It is essential to create the right framework for *sustainable innovation*. There is a need to:

- Develop strategic frameworks to enable long-term change orientated to *sustainable innovation* with buy-in from key government ministries/departments e.g. Treasury – however, this will need to be cross-ministerial/departmental if it is to succeed.

- Recognise the different levels of *sustainable innovation* and stimulate each level and type with need different approaches (see Section 2 for elements and levels of *sustainable innovation)*: a) incremental; re-design; functional; and systems and b) technologies/products/services; processes; organisational; and business).
- Use the policy toolbox (supply and demand-side) in a smarter way to stimulate the process of product/market development that sets stricter penalties for poor performance and more importantly provides positive incentives for good performance which may start to create more opportunities for *sustainable innovation*.
- Create the right framework to enable the implementation of both 'push' and 'pull' strategies for *sustainable innovation*: technologies/products/services; process; organisational; and business. A range of policies are needed rather than any one being a panacea.

Examples include:

- 'Producer responsibility' laws in Europe and Japan (Section 3) may provide a platform for a series of new (sustainable) business concepts in B2B markets e.g. 'take-back' services, pay-per-use (PPU) models, etc.
- Demand-side opportunities emerging for sustainable technologies/products/services in B2G markets in a range of countries. For example, the implementation of the Green Purchasing Law in 2001 in Japan has effectively created a *green* market in certain categories of public procurement which in turn has acted as stimulus to eco-innovation by companies on the supply-side. The publication in the UK in March 2007 of the Sustainable Procurement Action Plan may stimulate supply-side *sustainable innovation*.

Priorities

- There is a need to prioritise the focus for public policy on *sustainable innovation* e.g. buildings emit significant levels of carbon dioxide (CO2) and therefore should be a key target for improved performance (as highlighted by the EC Environmental Impact of Products (EIPRO) study).
- A mechanism needs to be put in place to stimulate design and development of new technologies/product/services that enable reduced energy consumption in the *use* phase e.g. changing consumer or user behaviour.

Learning from experience

- Lessons need to be learnt from the Japanese approach to stimulating the demand-side through the implementation of Green Purchasing Law (in 2001) and the establishment of the Green Purchasing Network [GPN] established 5 years earlier in 1996 (which had over 2800 members in 2006). This effectively meant that when the law was passed there was a critical mass of *green* procurement specialists, as well as products available.
- There is a need to capture experience from companies and government funded demonstration projects related to eco-design management. For example, the Dutch POEMS (Product-Oriented Environmental Management Systems) pilot project undertaken in the late nineties is a good case study. The underlying rationale for the demonstration project was that previous government funding had provided free advise to companies on eco(re)design of existing products, but when the project report had been completed for the firm, they often went back to 'business as usual' e.g. what was needed was a mechanism to integrate environmental aspects in product development processes (PDP) on a day-to-day basis.
- Therefore a key lesson was the need to link eco-design to management systems e.g. quality or environment or general, to ensure that environmental considerations were continuously integrated into the PDP. However, evidence suggests that the implementation of the POEMS pilot project did not necessarily lead to environmentally improved products (5/03).

- However, a major study on the impact of the implementation of the Eco-Management and Audit Scheme (EMAS) in Germany indicated that there was a positive correlation between the implementation of EMAS and eco-innovation of products (31/03).
- There is a need for a closer investigation of the reasons for the difference in the conclusions of these two studies.
- It is recommended that experience should be shared between VROM (Netherlands) on POEMS and Institute for Ecological Economy Research (Germany) on EMAS – which is then communicated as part of the lessons learnt for the product policy and SCP development process.

Considering scenarios

- A range of future sustainability scenarios need to be considered in the development of future public policy e.g. the EC funded Manufacturing Vision (MANVIS) and Future of Manufacturing in Europe (FUTMAN) projects provide interesting examples.
- For example, exploring a localisation (sustainability) scenario throws up a range of issues – any thoughts over local product design and manufacturing need to take of account of economic obstacles like cheaper manufacturing in South/South-East Asia – but focusing on localised remanufacturing may encourage more opportunities for local employment (7/05).

Developing countries (e.g. 11/04)

- Understanding what works in the North and then adapting it to the particular circumstances of the South is essential – attempts at straight replication will fail.
- There are degrees of poverty in the South and any approach to developing sustainable (new) business models needs to recognise this.
- Appropriate incentives are needed for micro-entrepreneurs in the South.
- In developing countries there is a need to focus on core competences, develop partnerships and localise 'value chains'.
- Many developing and newly industrialising countries have key positions in global supply chains and networks.

Policies for stimulating markets

Addressing market failures is a key issue – and governments need to understand how they can intervene earlier in product lifecycles to reduce environmental impacts of products and services e.g. at the design stage.

Table 6.2: Policies for stimulating markets

General

There is a need to:

- Consider how to re-orientate existing markets towards higher levels of sustainability, as well as how to create new markets that reward higher levels of sustainability performance (demand-side) e.g. sustainable public procurement, and stimulate *sustainable innovation* (supply-side).

- Quantify the estimated short/medium/long-term markets for *sustainable innovation* (technologies/products/services; processes; organisational; and business – estimates for the global market for environmental technologies vary but a typical estimate is over $700 billion (Source: DTI, 2006) excluding sustainable products, new technologies e.g. hydrogen-cells, etc.
- Increase momentum on sustainable public procurement and product policy – as if, for example, the UK wants to be a leader by 2009 and is ready to buy greener then the danger is that Japanese technologies, products and services will bought, as UK products will not have been designed and developed to include higher levels of environmental performance. To accelerate progress may require more focused and joined-up thinking in relation to the stimulation of the demand and supply of, for example, new sustainable housing, building and construction technologies/product/services.

Financial incentives

Appropriate mechanisms to reward long-term investment in *sustainable innovation* need to be developed.

- As prices are still a dominant factor in markets there is a need to consider how to use economic instruments to foster *sustainable innovation*. A major challenge is designing a framework that rewards leaders whilst encouraging the majority to improve whilst punishing laggards.
- For investors to be interested in products/markets they need to be shown an appropriate balance between risk and reward – *sustainable innovation* (technologies/product/services/businesses) has often seen to be risky and lacks short-term reward – however, there are some indications that this maybe changing in the US in 'cleantech'.
- The use economic instruments to foster *sustainable innovation* needs to be reconsidered e.g. the promotion of subsidies and lower indirect taxation for greener products – as prices are still a dominant factor in many B2C product/markets.
- There is a need to provide incentives for companies to integrate sustainability considerations into research and development (R&D) e.g. tax rebates, as well as, to allocate funding for public: private partnerships to complete longer-term strategic research into *sustainable innovation*.
- It is essential to get the prices right – but economic and fiscal instruments are controversial as highlighted by the IPP debate.

Green/sustainable public procurement (e.g. 4/06)

- There appears to be growing recognition that sustainable or green public procurement has a role in greening European markets – and the announcement that the UK wants to be a leader by 2009 reinforces the government's change in emphasis on SCP and products.
- The greening of public procurement provides opportunities for *sustainable innovation* as it represents around 16% of Gross National Product (GNP) and is potentially a key instrument but this maybe limited outside of specific product/service categories. To enable sustainable public procurement to happen will need training of procurers, reduction of the bureaucracy associated with government purchasing and greater availability of greener products.

Supply-side

Supply-side policy needs include support for 'eco-entrepreneurs'. As noted above, many such entrepreneurs lack sound business plans and clear business models – and need 'hands on' support.

Policies for sustainable consumption and production (SCP)

As noted above sustainability needs to be part of policies and strategies for SCP.

Table 6.3: Policy needs for Sustainable Consumption and Production (SCP)

Goals

- There is a need for clearer goals for SCP e.g. for reduction in carbon dioxide (CO2) the Kyoto Protocol sets targets but for reduction in resource consumption there is no such international target.
- The EC funded EIPRO project has indicated that four sectors have the highest level of environmental impact: food; drink; buildings; and transport

Considering globalisation and changing production patterns

- Globalisation has meant changing production patterns in the South e.g. a considerable amount of manufacturing and therefore environmental impacts are moving from the North to South and South-East Asia.
- The changing business model means global supply chains or networks of suppliers have major environmental and social impacts in a range of countries, societies and communities e.g. in China, outside of the point of final consumption e.g. in Europe.
- Production and consumption patterns will need to change to deal with continued and significant economic growth in India and China.
- Developing frameworks to encourage more sustainable patterns of consumption and production will ultimately mean new forms of international cooperation and partnership between governments and companies will be needed.

Integration into existing systems

- Several governments may be taking a lead on SCP but they are not necessarily integrating the thinking into their own systems e.g. there is a need to 'walk the talk'.
- Exploring SCP from a 'systems' rather than a 'silo' viewpoint may produce new perspectives.
- Examining demand and supply-side issues relating to SCP in a holistic manner and from a systems viewpoint may enable interactions and inter-connections to be seen more clearly.

System transformation

- To move towards more sustainable patterns of consumption and production will require a transformation of industrial systems and business models.
- Outside of regulated markets, it is difficult to make voluntary approaches work efficiently, as is seen even with simple measures such as take-back. To move towards cross-sectoral 'closed loop' societies and economies will need fundamental social and economic change.

Global cooperation

- As indicated above, there is a growing realisation that to create more sustainable forms of consumption and production will require international cooperation due to the globalisation of many supply chains (or networks).

Addressing consumption

The sustainable consumption element of the SCP debate is still a relatively new and emerging area.

- In western society there is a perceived right to consume – altering this has fundamental implications for market capitalism.
- Many policy decisions relating to changing patterns of consumption are at the frontier of what government's can do in terms of state intervention e.g. the ban on smoking in Ireland has set a precedent in Europe
- The 'customer is king' and is still the key driver for companies, alongside legislation
- The next generation provides a major challenge e.g. they want it all, but want to be *green*, if it is easy!
- There is a need for long-term consumer education.

Integrated product Policy (IPP)

Discussions on needs in this area were prominent. Although the term IPP itself has been going out of favour, the principles and needs for an *integrated* product policy approach remain (38/03).

Table 6.4: Policy needs in relation to IPP

Consider services as well as products

- On a government policy level, there is a need to recognise that many solutions offered by companies now include a combination of products and services.
- The EC Communication on IPP (2003) acknowledged the importance of services but excluded them in the focus of the document. There are key lessons to be learnt from EC funded projects on PSS e.g. SusProNet (44/03).

Cover *sustainable innovation*

- The IPP Communication did not explicitly cover *sustainable innovation*.

Recognise the needs but also limitations of legislation and other policy instruments

- A number of papers presented at the *Sustainable Innovation* conferences reinforced the importance of legislation as a key existing and potential driver for improved sustainability/ environmental performance by business – however, the 'bottom-line' for companies is the need to act when customers start asking questions.
- Many recognised that legislation is a blunt instrument and it is only one of a series of policy tools that can be used to influence the demand and supply sides.
- Taxation was mentioned as a potential tool by many authors (however, the IPP Communication dropped this due its contentiousness) – impacting on the price of products will provide powerful messages.

Importance of green public procurement

- A number of conference papers reinforced the perceived opportunity for governments to take the lead in creating markets through sustainable or green public procurement, as has happened in Japan.

Consider the roles of stakeholders and networks in fostering *sustainable innovation*

- On the supply-side there is a need to consider the role of a) entrepreneurs and b) inventors in helping foster *sustainable innovation* – this seems to have been ignored in existing IPP discussions.
- There is a need to create networks to bring together the right stakeholders to facilitate and catalyse *sustainable innovation* – as this does not seem to happening naturally. IPP has a clear role to play in helping to facilitate this process.
- Key groups that need to be engaged in the discussion include: a) entrepreneurs b) inventors; c) the investment community; d) researchers and e) marketing professionals.

New policy tools

New policy tools need to be experimented with. Various approaches were presented and discussed in the conferences.

Table 6.5: Example of a new policy approaches

Long Term Agreements

- The Dutch are using Long-term Agreements (LTA), a policy instrument that creates flexible, voluntary agreements to create targets for CO2 reduction (32/05).
- In line with this, the network of Dutch Innovation Centres (Syntens) have used a combination of tools to stimulate the development of energy efficient products e.g. PSSs, Innovation Scans and the Energy Innovation Scan (EIS) tools (based on the Environment Innovation Scan (EiS) tool that produced hundreds of examples of eco-innovation). Results of this approach are unclear, as yet. However, a key lesson from the process is that it takes time to raise awareness of benefits of such approaches.

7 Needs for implementation in business

One conclusion from the conferences is that organisational and business dimensions of *sustainable innovation* are particularly poorly understood and there is a general need to improve understanding. Experience from leading companies suggests that embedding *sustainable innovation* into existing processes and systems is essential but difficult and time-consuming.

Based on the experience of companies and on conference discussions, some of the key elements for successful implementation of *sustainable innovation* in organisations are summarised in this section.

General requirements

Sustainable innovation needs to be implemented as part of an appropriate strategic approach.

Table 7.1: General implementation requirements

Mission and shared vision

- To progress *sustainable innovation* within the firm there is a need for a mission statement highlighting the companies' sustainability commitment. Without this legitimacy it is hard work.
- Philips (6/03) has found that Corporate and Business Units (BUs) need a shared vision of the proposed outputs of the eco-innovation process e.g. Green Flagship products.

Senior management buy-in

- *Sustainable innovation* – at whatever level – needs to presented to senior management using business language, if organisational 'buy-in' is to be achieved. *Green* does not sell (37/05) but it can produce cost reduction and other benefits.
- There is a need to get senior management endorsement and commitment at a policy level for initiatives to progress.

Business case

- The business case needs to be continually developed and communicated – however, it is becoming an increasingly competitive issue (44/05).
- To get management 'buy in' there is a need to achieve 'quick wins' and to prove pay-back.
- To ensure implementation it is also essential to sell the commercial benefits of eco-innovation or broader *sustainable innovation* approaches in the language of different business functions e.g. to Marketing in marketing language. If projects are only sold in sustainability/environmental language they will hit the 'green wall' and move no further.

Integration and embedding in existing organisational processes

- Philips (6/03) and SC Johnson (27/03 and 1/06) have learnt that embedding eco-design into organisational processes is key.
- To hardwire eco-design into the organisation there is a need for internal branding and marketing of programmes (e.g. SC Johnson's Greenlist ™) (27/03) and this requires working with and integration into existing processes rather than eco-design being treated as something separate.

Explore opportunities for generating product-related environmental value

- As noted above, some leading companies now claim to have achieved the limits of functional/ technical improvements from eco-design (37/05) and are now seeking new ways of generating product-related environmental value.
- Companies need to establish systems to identify and recognise emerging sustainable (new) business opportunities.

Learning through pilot approach

- A number of large companies choose to develop pilot projects to increase understanding of *sustainable innovation* before attempting to implement sustainability criteria in their new product development processes.

Ongoing development (not one-off)

- Lessons from SC Johnson's approach to eco-design are that innovation tends to be frequent e.g. month-to-month and incremental.

Working with suppliers

- Increasingly, due to the changing business model, there is a need to develop good relationships with materials suppliers to enable product-related environmental improvements to be realised.
- Experience also suggests that to ensure the systematic and continuous integration of environmental considerations into the product development process (PDP) there is also a need to establish mechanisms to share and communicate knowledge throughout global supply networks.

Organisational needs

There is a need to recognise the business, management and organisational challenges associated with implementing *sustainable innovation*. To foster *sustainable innovation* requires appropriate organisational design e.g. siting the marketing manager's desk by the sustainability manager's desk mean conversations happen that would not in the normal course of business. Challenges that need to be tackled include organisational 'buy in', manpower and resources.

The Philips, SC Johnson and other examples illustrate that there is a need for a better understanding of the organisational dimensions of *sustainable innovation*.

Table 7.2: Organisational needs

Vision and leadership

- To accelerate *sustainable innovation*, vision and leadership is essential – but it is not easy! Many companies are keen to be followers and are not prepared to take the risk of being first!

Culture

- Organisations need to create a culture that rewards experimentation e.g. people need 'room and space' to channel creativity in the direction of higher levels of *sustainable innovation*.

Integration into existing processes

- A key issue is to ensure that appropriate organisational and business processes and models are in place to ensure that sustainability is continuously integrated into existing processes.

Integration into product development and technology

- Companies need to understand the contribution that new product development (NPD) can have on achieving sustainability objectives and adding value.
- There is a need to incorporate sustainability into the creativity phase of new product/service and business development processes. Few companies are doing this which means there is still relatively little *sustainable innovation* (technologies/products/services).

Roles and responsibilities

- There is a need to establish a clear demarcation of responsibilities e.g. at the product-level, environmental considerations are product-specific and should be left to Business Units to determine.

Developing capabilities

- Organisational capabilities need to be developed across relevant business functions especially the design function (see below).
- There is a growing realisation that for many products the biggest environmental impact is the energy consumed in the *use* phase of the product or service. This indicates that there is a need for marketers and designers to increase their understanding of user behaviour to enable the design of more energy efficient solutions (e.g. 26/03)
- Organisational learning and knowledge management are important tools – more mature eco-design management systems are likely to produce more *sustainable innovation*.
- Industry will need to learn new skills e.g. they know how to assemble, but they don't how to dis-assemble (20/04).

Developing innovation networks

- One important aspect of innovation is the development of innovation networks. For example, to progress *sustainable innovation*, InterfaceFlor Europe took the decision to go outside the company and establish an external expert network that works closely with the company to develop a range of new concepts and projects (e.g. 14/04)
- There is a need to explore actor interactions e.g. to enable networking and cooperation of employees, customers, suppliers and others, and to design processes (interaction management) that create direct and indirect spin-offs e.g. Dow Corning (17/05).
- An interesting approach to foster *sustainable innovation* within firms is to explore and adapt inter-preneurship models e.g. to create new internal entrepreneurial inter-connections aimed at the discovery and realisation of innovative (sustainable) solutions (Charter & Tischner, 2001).

Role and needs of designers

The conferences especially focused on the role of the designer in *sustainable innovation* and needs for development.

Table 7.3: Role and needs of designers

Important potential contribution to *sustainable innovation*

- Product designers have strengths in creativity – but as yet these skills have not been significantly applied to the development of new innovative sustainable technologies, products and services.
- Sustainability-aware 'design entrepreneurs' may start to see opportunities to create new sustainable products or product-service combinations if they can identify markets, find interested customers, have an appropriate business model and are prepared to take risks.

Consider types of designers and interractions

- There are many types of designers: product; engineering; packaging; civil engineers; architects; city/town planners, etc. Each design discipline faces specific issues but there are certain cross-cutting issues e.g. need for lifecycle thinking (LCT).
- A key issue underlying these discussions is what is design? where does it happen? and what are the issues related to different scales of production: mass (large scale); batch (small-medium scale); and craft production (small scale).
- There appears to be little dialogue and connection between the various types of designers over common *sustainable innovation* and SPDD issues with much of the debate focused on manufactured products and services.
- There is a need for framework change on the demand-side and there needs to be catalysts on the supply-side e.g. 'thought-leaders'. Can designers be those catalysts? are designers a potential agent of behavioural change? or do designers need to recognise their limitations and their change their mindset? what is the role for design educators and associations in this process?

Awareness and training

- Generally, product designers are still at an early stage of their understanding of environmental and broader sustainability issues due to a lack of awareness and education in the issues, and more importantly because of little present internal and external (customer) pressure.
- Product designers use different mental models and generally do not fully appreciate the life cycle impacts of their decisions – but this needs to change (24/06).
- However, design engineers in large companies in certain sectors are increasingly practising eco-design and recognising the opportunities to 'add value' e.g. in Japanese and other electronics companies.
- There needs to be more awareness amongst and education of designers over the attributes and benefits of sustainable materials e.g. biomaterials.

Need for inspiring examples

- Product designers need inspiring examples of sustainable products to switch them onto the issue – if they are not to consider sustainability to be a threat-based agenda, constraining their creativity. They also need to recognise the opportunities for innovation.
- There are many examples of more sustainable products but they are not sexy – and tend to cluster around a few product categories e.g. bags and furniture (8/05).

Need for tools and methodologies

- There are a range of eco-design and SPDD tools and methodologies starting to emerge – however there is no common viewpoint.
- To engage conceptual 'right-brained' product designers as opposed to more 'left brained' design engineers there is a need for visual tools and 'learning by doing' techniques based on practical demonstration projects – as yet, these do not really exist in the public domain.
- Tools to foster creativity are potentially useful (e.g. 9/06 on biomimicry).

Need for team approach

- Designers will not drive sustainability by themselves but they can play a part – and expectations should be realistic.
- Sustainable design academics need to recognise that the designer is part of system and to progress *sustainable innovation* or SPDD they need to work as part of wider team and other internal and external issues need to be tackled, many of which they have no control over.

Changing design and production processes

The geographical position of design, assembly and manufacturing is changing with growing shifts to low-cost countries e.g. China and it is necessary to consider where design and manufacturing decisions are now made and will be made in the next 5 and 10 years. In a globalised world, *sustainable innovation* or SPDD now requires the conceptualisation of complete supply chains (or networks) and therefore for more holistic, systems-based thinking skills. SPDD is different from eco-design, in that it takes account of social and ethical considerations alongside more traditional environmental and financial aspects.

Technology diffusion, patents and intellectual property

Innovative, sustainable technologies need to be widely adopted in order to address sustainability problems and so systems need to be developed to foster technology diffusion while protecting the commercial interests and intellectual property of innovators.

One suggestion in the discussions was the need for the development of systems to foster higher levels of *sustainable innovation* patents.

Among issues identified relating to technology diffusion was the need to address confusion regarding new materials e.g. bioplastics.

8 Needs for collaboration in developing *Sustainable Innovation Systems (SIS)*

To enable more sustainable patterns of consumption and production will ultimately mean that new forms of national and international cooperation and partnership will need to be created between governments and companies.

Sustainable Innovation Systems (SIS)

SIS covering key technologies/products/services needs to be nurtured and developed outside, between and within firms. Processes to enable and then manage interactions (interaction management) needs to be fostered and cohesive communities and/or networks between direct/indirect stakeholders need to be built.

At a macro level, Fichter from Borderstep Institute for Innovation and Sustainability in Germany suggests some key elements for enabling *SIC* (Table 8.1) (13/05).

Table 8.1: Elements for enabling *SIS*

Key elements

There are five key aspects related to *SIS*:

- Sustainability requirements
- Innovation determinants
- Innovation process
- Actors, networks, interaction
- Innovation effects.

To enable *sustainable innovation*, Fitcher suggests that there is a need for:

- Partner cooperation along the value chain
- New arrangements
- Demand-side changes.

Sustainable Innovation Communities (SICs)

SICs aim to support the breakthrough of technical, social, environmental innovation (as distinct from R&D communities or networks).

Are *SICs* communities or networks? They can be both and/or either and can exist virtually, physically, independently, between or within organisations. For both or either, informal and formal relationships are key components and various levels of interaction may exist: material; information; and understanding.

Table 8.2: *Sustainable Innovation Communities (SICs)*

Key elements

SICs may take various forms:

- Contact network
- Virtual community (for idea generation and evaluation); or
- Promoters of specific projects.

The focus of *SICs* may be on:

- Research
- System solutions
- Market and users
- Multi-actors
- Production technology and logistics.

To be successful there needs to be the development of a common basic understanding and self-identification with the community or network. It is essential to shape communications processes/ personal encounters for actor cooperation and networking (interaction management).

Policy needs for *SIS*

Various proposals arose out of the discussions.

Table 8.3: Policy needs for creating *SIS*

General

To accelerate the *sustainable innovation* process there is a need to:

- Identify *SIS* catalysts, change agents and networkers.
- Improve the recognition of the characteristics of and opportunities for the creation of *SIS*.
- Make better connections between stakeholders in the *SIS* e.g. investors, inventors, entrepreneurs, academia etc, including information flows between these stakeholders.
- Create bridges to enable more effective transference of *sustainable innovation* research and knowledge into the 'real world'.
- Bring together clusters of often disparate stakeholders to create more optimal *SIS*.
- Establish new forms of partnership and cooperation to develop more sustainable (new) business models – this is starting to emerge in some areas as highlighted by the SusProNet work (44/03).
- Develop trust and 'buy in' amongst all parties. Developing sustainable (new) business models means involving, cooperating and partnering with people.

International cooperation and partnership

- Existing and new networks should be used to learn from other countries that have developed environmental product policy.
- Partnership should be established with leaders e.g. the Dutch to learn from their pioneering experiences of a) running major eco-design programmes in the nineties, b) using new policy approaches e.g. LTAs and c) research on eco-innovation.
- Policy-makers need to appreciate that the manufacture of many technologies/products/services is increasingly in South/South-East Asia. Therefore to develop solutions, new forms of international cooperation will need to be fostered e.g. the UK Market Transformation Programme (MTP) have established dialogue with the Chinese over energy use of set-top boxes.

- Opening communication with China, India and newly emerging economies e.g. Vietnam, about links to European SCP policy developments and the Marrakech process.

Support for entrepreneurs and sustainable enterprises

- Entrepreneurs that recognise opportunities related to the sustainability agenda can create sustainable enterprises. A sustainable enterprise can be described as 'a firm that aligns its operations and growth with providing solutions to the world's pressing social and environmental problems' (World Resources Institute) (5/04).
- Many 'eco-entrepreneurs' lack sound business plans and clear business models.
- There is a need to identify inter-, entre- and intra-preneurs that are able to foster *sustainable innovation* and then mechanisms to activate the commercialisation process.
- For example, the UK is a nation of 'potting shed inventors'. New ideas and opportunities need to be recognised and inventors need to be more effectively linked to entrepreneurs, funders and others. Concepts should not be lost e.g. the Baygen clockwork radio was funded and developed in South Africa after being invented in the UK by Trevor Baylis and being 'turned down' by investors and opinion-formers in the UK. The original technology was subsequently successfully adapted by Philips and Sony who both produced successful dematerialised versions of the product.

Role of other players

- A significant amount of sustainability thinking has been dominated by technicians, scientists and pressure groups – there is a need to bring much higher levels of creativity and problem-solving to the debate to solve key global problems e.g. climate-change.
- Key opinion-formers and decision-makers can 'open doors' – however, the opportunities for *sustainable innovation* are not being recognised.
- There is a role here for non-governmental organisations (NGOs) to stimulate *sustainable innovation* through campaigns and highlighting the need to change existing unsustainable consumption and production patterns.

Education

- Environmental and broader sustainability considerations need to be integrated into university and other higher education curriculum e.g. business schools, product design and design engineering curricula.
- In addition, business schools need to be targeted to ensure sustainability considerations are being built into MBA modules or even sustainability-driven MBAs need to be developed e.g. Presidio World College in San Franscisco (US).
- Finding a poverty alleviation connection to enable the release of overseas aid may not always be easy. To create more *sustainable innovation* will require more education and training in the South – but how this is funded is a key issue.

9 Needs for further research and understanding

Many of the papers presented the results of ongoing research whilst discussions raised many issues needing further work and better understanding. Some of the main needs are summarised here.

Table 9.1: Needs for further research

Analysing obstacles

- Analysing the problems, barriers and obstacles to *sustainable innovation* associated with existing social, legislative, economic and management systems will highlight new business, organisational and product development models and opportunities.
- A considerable amount of discussion at the conferences focused on the need for change, transformation, re-thinking existing attitudes and shifting behaviour e.g. 'If you truly want to understand something, try to change it!'
- New market research techniques are required to explore how consumers really use technologies/products/services and the potential opportunities to reduce the environmental impacts of use and consumption e.g. through the completion of activity/user diaries and ethnographic techniques, etc.

Creating positive stories

- Positive stories need to be created (both aspirational and inspirational) and negative stories need to be avoided (despairational) – this means working with the media.

***Sustainable innovation* in relation to SCP**

- There is a need to develop a more concrete understanding of what is the role of *sustainable innovation* in the SCP debate (demand-side and supply-side).
- It appears that *sustainable innovations* e.g. technologies/products/services have come primarily from the supply-side, so a key issue is how to create appropriate demand-side signals e.g. sustainable or green public procurement initiatives that stimulate more market-focused *sustainable innovation*.
- It would also be useful to take a broader look and learn lessons from the barriers to and opportunities for *sustainable innovation*.
- There is a need to better understand how to move from green niches to green mass markets.

Creating *Sustainable Innovation Systems (SIS)*

- To enable *sustainable innovation* there should be consideration of how to design and implement SIS through the creation of clusters and/or networks of entrepreneurs, inventors, investors, experts and academics.
- There is a need to spot *sustainable innovation* opportunities and raise awareness of these amongst proven entrepreneurs and others.
- Matching appropriate stakeholders to opportunities for new, or new combinations of technologies/products/services coupled to appropriate funding and commercialisation expertise is essential.

Organisational aspects of sustainable innovation

- One of the weaker areas of understanding is the macro and micro organisational dimensions of *sustainable innovation*. There is need for more research into:
- Better mechanisms to stimulate *sustainable innovation* in the process or cycle: at the creativity stage of product development (company); and early in innovation/technology cycles (government).
- How to create/nurture/develop the process of *sustainable innovation*: within large and medium-sized companies; between large and medium-sized companies; within entrepreneurial 'start ups'; between entrepreneurial 'start ups'; within governments; and between governments.
- The constraints to innovation and *sustainable innovation* within large companies (as outlined in Section 5).
- Marketing's potential role in fostering *sustainable innovation*. The profession has a pivotal position at the interface of production and consumption issues. However, as yet, marketeers are generally not involved or engaged in the SCP or *sustainable innovation* debate.

Role of academia

The possible role(s) for academia in the *sustainable innovation* debate should be better defined.

Some issues include:

- How to involve Business Schools and their alumni, who will include the existing and next generation of entrepreneurs and investors.
- Better linkages and partnerships between academia and business e.g. improving students/researchers understanding of the commercial realities and implementation issues related to *sustainable innovation* and facilitating better knowledge transfer.
- The potential role as pre-commercial catalysts for radical *sustainable innovation* concepts (functional and 'system innovation' – see Section 2).
- In addition, there are many research gaps related to *sustainable innovation* e.g. there is weak understanding of social aspects, organisational dimensions, etc – these 'missing links' in knowledge provide a range of opportunities for researchers.

Research calls, tender and programmes

It was proposed that research calls, tenders and/or programmes might be developed to:

- Explore the implications and opportunities for *sustainable innovation* resulting from a range of sustainability scenarios (building on existing studies e.g. FUTMAN and MANVIS).
- Explore issues, constraints and opportunities for *sustainable innovation* in food, drink, housing and transport e.g. the sectors identified – in the EIPRO study – as having significant environmental impact.
- Learn the preconditions and processes that have enabled *sustainable innovation* to arise in certain sectors and companies; and potential transferability to other sectors and companies.
- Determine the business development and employment potential (e.g. from entrepreneurial 'start-ups') resulting from a longer-term and more progressive policy approach to *sustainable innovation*.
- Assess appropriate eco-design support structures for SMEs related to the requirements of the EuP Directive.

- Evaluate the results and success of the Dutch Product-Oriented Environmental Management Systems (POEMS) project in lieu of the EuP Directive.
- Explore the organisational dimensions associated with implementing *sustainable innovation* programmes.
- Improve understanding of consumer behaviour and usage patterns related to EuPs.
- Explore a) Marketing's and b) Supply Chain Management's potential roles in stimulating *sustainable innovation*.
- Stimulate R&D into new sustainable materials.

Examples of sector needs

Food and packaging

- In the UK, an estimated 80% of food products are disposed after a single use. With the challenge of achieving Landfill Directive targets, mechanisms to stimulate sustainable (packaging) design will become increasingly important.
- Waste & Resources Action Plan (WRAP) in the UK is working with retailers on innovative sustainable packaging concepts, but are facing major challenges associated with entrenched consumer attitudes, behavioural change and 'system inertia'.

Building and construction

- Lifecycle thinking (LCT) is rarely practised which means that there are information gaps and losses at different life cycle stages. For example, at the 'end of life', dismantling is often not planned effectively due to a lack of knowledge about sites. Traditional planning focuses on the erection of the building but 70–80% of total costs are in the *use* phase.
- There is a need to think more holistically about the total planning process to identify opportunities for *sustainable innovation* or SPDD. To improve this there is a need to understand who are the real decision-makers and what decision-making processes are really used e.g. the site manager often defines the method of construction and many of materials used.
- There is growing concern over the energy consumed in the *use* phase of buildings and offices, as this a major contributor to global CO2 emissions. The need to raise awareness over buildings' lifecycle environmental impacts is becoming a key issue with little practice of *sustainable innovation* or SPDD in the housing, building and construction sectors.
- Thinking of opportunities to reduce energy consumed in the *use* phase therefore means the need to focus on areas such as material selection and user interface design.
- The development and use of A/B/C ratings might provide a simple communications device to enable specifiers to differentiate materials and their suppliers.

10 Conclusions

This booklet has provided a brief overview of the *Sustainable Innovation* conferences during the period 2003–2006 and drawn the main conclusions from the diverse range of presentations, papers and discussions.

There should be no doubts regarding the timeliness and importance of the conferences and their continuing contribution to the debate as sustainability issues increasingly move to centre stage in government, business and society.

The urgency of *sustainable innovation* is becoming internationally recognised as a vital contribution if not a panacea towards a sustainable future. The economic and business opportunities are also being recognised as immense. There are emerging positive signals of strengthening drivers and activity by governments and business.

Recognition and discussion of the problems, however, is far from universal and recognition does not inevitably lead to a solution. Societies, economies and markets are still a long way from making the necessary changes to create widespread demand for sustainable products and services, and therefore demand for *sustainable innovation*.

It is still early days and there is much to do. The many obstacles and challenges summarised in this booklet remain to be overcome. Much more needs to be done to shift markets towards sustainability and encourage the majority of businesses which have yet to seriously address the issues. There is a continuing need for research to increase understanding of the complexities of the challenges and opportunities for *sustainable innovation.*

There are many exciting challenges ahead and the *Sustainable Innovation* conferences look forward to drawing together the international community of researchers, thinkers and practitioners in helping to address them.

11 Further information

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The Centre for Sustainable Design has a range of material on *sustainable innovation* that can be freely downloaded from **www.cfsd.org.uk**. Of particular interest may be eco-i net: network for eco-innovation; and the *Sustainable Innovation* Network.

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