The Role of Ergonomics in Design for Sustainability

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Abstract

Design for Sustainability, whilst a relatively new research area, has traditionally focussed on improving existing products and services with respect to their environmental impact. However it has now been widely recognised that this incremental and purely technological approach is unlikely to result in the significant changes needed if we are to have a more sustainable society. This paper outlines existing approaches to Design for Sustainability and explores the way in which users need to be considered in more detail for more sustainable solutions to be designed. It outlines the crucial role that ergonomics now plays within Design for Sustainability and presents new opportunities for designers and ergonomists to work together beyond their traditional boundaries enabling more sustainable design solutions in the future.

1. Introduction

For a number of years it has been widely recognised by governments and industry that current human activities degrade the environment and cause serious negative consequences for human populations (Brundtland, 1987) and as such we need to identify more sustainable patterns of development. A reduction of the environmental impact of human activities by of factor 10 is now recognised as a key target. Considerable research (Bhamra & Lofthouse, 2008) has been carried out to understand how socially and environmentally responsible considerations can be integrated into the product development process to enable more sustainable design.

Designers shape the development of products and services which directly impact upon society and the environment. Design for Sustainability as a subject has developed considerably over the last fifteen years with the increase in awareness of environmental and social issues in industry (Von Weiszacker, Lovins & Lovins, 1997). Until recently, the usual response to environmental problems was to reduce pollution and waste after it had been produced. Attention then moved away from these ‘end-of-pipe’ approaches to ‘cleaner’ manufacturing which results in less waste and pollution being generated. There was then the realisation that major environmental impacts arise from the material choices and from the use and disposal of products (Roy, 2000). The most advanced companies are now moving beyond the compliance mentality and being proactive in shaping future markets, consumer needs and influencing legislative developments. They see sustainable development as an opportunity rather than a threat, recognise that ‘prevention is better than cure’ and are attempting to ‘design out’ rather than simply manage the problems. Design for Sustainability now goes beyond the consideration of environmental issues and recognises the importance of social and ethical issues in design. The application of design for sustainability can greatly reduce the environmental and social impacts of products and services.

2. Design for Sustainability

The concept and practice of design for sustainability is the response from the design community to increasing environmental and social pressures, limits and awareness. The last two decades have seen a proliferation of terminology relating to the incorporation of environmental considerations into design but generally this falls into three different approaches, green design; ecodesign; and sustainable design:

- **Green design**: has a single-issue focus, perhaps incorporating the use of some new material, such as recycled or recyclable plastic, or consider energy consumption.
• **Ecodesign:** adopts the lifecycle approach, exploring and tackling all or the greatest impacts across the products lifecycle.

• **Design for Sustainability (or Sustainable design):** takes a more broad and holistic approach, including: questioning/addressing needs; concern for ethics and equity, services and leasing.

The life cycle of a product, service or system has many stages starting with the extraction of the raw material required to produce it, moving on to the processing of those materials, through to manufacture, purchasing by the consumer, use by the consumer and then disposal, followed by any reuse or recycling which may occur.

![Figure 1 Product Life Cycle](image)

Life cycle thinking in design aims to identify possible improvement in the form of lower environmental impacts and reduced resource use across all life cycle stages. While doing this it is important to ensure that these burdens are not shifted from one lifecycle stage to another. Overall the whole life cycle should be improved. This should mean the project is working across the boundaries of an organization to make sustainability marketable, tractable and profitable. Life cycle thinking provides a broader perspective in design. As well as considering the environmental impacts that are within the direct control of the organisation, attention is also given to all raw materials use, supply chains, product use, the effects of disposal and the opportunities for reuse and recycling.

Models are used to explain sustainable design in more detail and one by Brezet (1997) provides a clear outline of the key design criteria and consideration. This model proposes a four-step model of sustainable design innovation and is illustrated in figure 1 below. These steps are described as:

• **Product improvement:** The improvement of existing products with regards to pollution prevention and environmental care. Products are made compliant.

• **Product redesign:** The product concept stays the same, but parts of the product are developed further or replaced by others. Typical aims are increased reuse of spare parts and raw materials, or minimising the energy use at several stages in the product life cycle.

• **Function innovation:** Involves changing the way the function is fulfilled. Examples include a move from paper-based information exchange to e-mail, or private cars to ‘call-a-car’ systems.

• **System innovation:** New products and services arise requiring changes in the related infrastructure and organisations. A changeover in agriculture to industry-based food production, or changes in organisation, transportation and labour based on information technology.
To move from level 1 to level 4, increasing amounts of time and complexity are required, which leads to higher levels of improvements towards sustainability. This model suggests that these more complex innovations can only be achieved over a significant time period, say 10-20 years and by approaching design for sustainability in new ways.

At level 1, product improvement, the focus is on partial changes and improvements to the existing design outcomes. This is by focusing on pollution prevention measures such as materials substitution or making the design outcome energy efficient as well as complying with legislation.

Product redesign, level 2, involves taking a lifecycle perspective during design, which means considering the intended and unintended environmental and social impacts across the whole of the lifecycle. The design concept remains the same but some elements are developed further or replaced. Resource efficiency is often a good starting point when thinking about redesigning products, services or systems. Designers look for opportunities to reduce material and energy used throughout the lifecycle of a design concept. By doing so, it is possible to not only reduce the environmental impact of products and at the same time reduce costs. This evolutionary approach integrates environmental and social considerations into existing design practice. The key words are product modification and pragmatism.

Moving to level 4, function innovation, requires a more holistic approach whereby the designer should look for opportunities to change the way the function of the design outcome is fulfilled. Sustainability considerations should be used as the driver for new and more radical concept developments. This uses a more revolutionary approach because many consider that existing products and services, as well as patterns of production and consumption, can never lead to sustainability. It needs to be multi-disciplinary, extending beyond single or traditional design outcomes and organization boundaries. This requires a different approach to developing products, services and systems.

Finally achieving level 5, system innovation, requires the designer to move outside of the traditional boundaries of design to consider how a new system can deliver significantly better performance from a sustainability perspective. It may also involve the replacement of an entire technological system. These changes are likely to require changes in the related infrastructure and organization and as such may be impossible for designers to influence on their own. This requires a different approach to developing products, services and systems. Systems embody the potential for sustainable innovative ideas for organizations in different socio-economical contexts, because they link sustainability with existing and emerging dynamics of economic and cultural change.

3. Opportunities for Change

As Brezet’s model shows there are many different approaches to tackling design for sustainability with many different types of design outcomes and with different levels of environmental and social benefits. If we are going to help move towards a more sustainable society then we need to start looking at adopting the more radical approaches to design for sustainability, i.e. Function Innovation and System Innovation.
These more radical approaches to design do not begin with the idea of a product solution but starts with the consideration of what the product satisfies (such as the need for warmth) and considers if that need could be met in another more sustainable way. The best design for sustainability outcome may not be a new product, but a new system or mode of product use. For example, car share systems reconfigure the perception that we as consumers need a new car; what we really need as citizens is access to transport. This requires designers to work in a new way that is more interdisciplinary and even across different professions. Designers need access to the knowledge and skills regarding human characteristics and capabilities, as well as user needs and desires during use and interaction with products in work activities and everyday life, these can be provided by ergonomists (Tosi, 2012).

If designers and ergonomists have this as their starting point for design for sustainability then many more sustainable solutions will emerge. Rather than just making small incremental improvements to existing products we can ensure that future innovative solutions not only deliver high levels of customer satisfaction but also radically reduced environmental and social impacts. The next, inevitable, step is to ask how design interventions can direct us as citizens (not just consumers) onto a more sustainable path.

4. Design for Sustainable Behaviour

As illustrated earlier, in simple terms the lifecycle of a product, service or system consists of raw material acquisition, manufacturing, use and disposal. Until recently the main focus for the incremental approaches to design for sustainability has been the first, second and last stage of the life cycle. However, the use phase has been identified as having significant environmental and social impacts, which are largely determined by the consumers’ behaviour (Environmental Change Unit, 1997). To reduce the impact of the use, technological innovation alone is not sufficient, a fundamental shift in behaviour is required a shift which could be initiated by innovative product, service or system design.

This new field of enquiry is exploring how design and ergonomics together can influence user behaviour to reduce negative social or environmental use impacts. Previous investigations (Lilley, 2007; Tang, 2010) identified seven strategies which can be applied within design. This work provided an understanding of the psychological and behavioural factors of behavioural change and identified ways in which they could be applied within a design context (Bhamra et al, 2011).

Figure 3 below illustrates these approaches and shows how the power in decision-making, relating to the behaviour, shifts from the user to the product, service or system.

![Figure 3 Seven Design for Sustainable Behaviour Approaches (Bhamra et al, 2011)](image)

Eco-Information can be considered as design oriented education, making consumption visible, understandable and accessible to the consumer to enable them to reflect upon their use of resources. Eco-choice moves towards design oriented empowerment by encouraging consumer to think about their use behaviour and take responsibility for their action, it does this by providing consumer with options. Eco-feedback provides design oriented links to environmentally and/or socially responsible action by clearly informing users about what they are doing and facilitating responsible decision-making. Eco-spur
moves to a design oriented incentive or penalty system by prompting good behaviour and punishing unsustainable use. Eco-steer provides design oriented affordances and constraints enabling users to adopt sustainable use habits through prescriptions or constraints of use embedded in the design. Eco-technical interventions aim to restrain existing use habits and to persuade or control user behaviour atomically through the use of advanced technology in the design. Finally, clever design automatically acts in a sustainable way without raising awareness or changing user behaviour, this is achieved by the way in which the product, service or system is designed.

As part of Design for Sustainable Behaviour ergonomics provides structured methods designed to evaluate user-product interaction, and to identify and interpret user needs, expectations and desires. The ergonomic approach can represent both the starting point of this new design process and from the knowledge of user needs and expectations, from their interpretation based on structured survey and evaluation methods of the User-Centered Design approach - and at the same time, the tool for assessing their appropriateness and effectiveness.

Despite this recent research design for sustainable behaviour remains a relatively unexplored field by both designers and ergonomists and has yet to result in radical new products, services and systems. However by again moving beyond the traditional boundaries of design we can enable users to be more sustainable either consciously or unconsciously by providing solutions that have considered real user behaviour.

5. Conclusions

Until recently design for sustainability techniques only tended to focus on increasing energy efficiency, using recycled materials, reducing toxicity or extending product life. This paper has illustrated the new ways that designers and ergonomists together can work to ensure that their designs really contribute to sustainability and ensure the future for the environment and society. By moving beyond their traditional boundaries designers have the opportunity to provide solutions to real needs that are no longer confined to only products but also provide services and systems. In addition by building a detailed understanding of the user of the product service or system they are able to ensure that their intended sustainability benefits can be achieved no matter who the user is or the context in which use occurs.

References


