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Beyond the product lifecycle: from product life to material life

Abstract

The concept of Sustainable Consumption and Production (SCP) is of increasing interest to government, industry and researchers. Strategies and actions to improve product lifespans is just one of many contributions that design is investigating as a part of the SCP agenda. Drawing examples from the consumer electronics sector, this paper considers the likely effectiveness of product lifespan strategies to mitigate environmental and social impacts. It argues that behavioural and structural obstacles, which lay behind product obsolescence, can undermine design for product lifespan strategies. By shifting emphasis from design for product life to design for material life, many of these behavioural and structural obstacles could be avoided. The imperative shifts from prolonging product life to prolonging material life (the stuff from which products are made of), in the consumption production economy. This can be achieved, in part, by building new alliances with the growing de-manufacturing sector opening up new possibilities for design innovation. Material lifespan strategies are surveyed with specific reference to the consumer electronics sector. Design for material life could effectively tackle escalating consumption, especially in fast growing sectors such as consumer electronics goods.

Keywords

- design and sustainability
- sustainable consumption
- sustainable production-consumption
- sustainable system innovations
- product lifespans

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1.0 Introduction

Despite growing interest and knowledge in design for product lifespans (Van Hinte, 1997, Park, 2003, Cooper, 2005, Van Ness, 2003), design solutions that address sustainable consumption and production (SCP) remain allusive. Rapidly increasing consumption and shortening product lifespans contribute to significant environmental and social impacts. Much of the effort in tackling such impacts has focused upon improving production efficiencies and reducing waste. However, the bit in the middle, consumption, is often overlooked. Designers and advocates for sustainability have, in the past, poorly understood the complex behavioural and structural issues behind our consumer culture. Leading to little integration or coordination to harmonise efforts to mitigate impacts throughout the entire product lifecycle – from cradle to grave. Strategies and actions to improve product lifespans is just one of many contributions that design is investigating as a part of the SCP agenda. Consideration for product life is a well established part of the eco-design repertoire available for designers (Tischner, 2000, Lewis, et al, 2001, Envirowise, 2004). We now have a good general understanding of the many diverse factors that lie behind product obsolescence, as well as a toolbox of useful product lifespans strategies.

But, how effective are these strategies? Material consumption continues to soar in most consumer product sectors, contributing to an overall pattern of unsustainable consumption and production. This paper considers the likely effectiveness of product lifespan strategies to mitigate environmental and social impacts. With examples drawn from the consumer electronics sector it is argued that technological, behavioural and structural obstacles, that lay behind product obsolescence, can undermine any product design lifespan strategies. By shifting emphasis from product life to material life (the stuff from which products are made of), many of these technological, behavioural and structural obstacles could be avoided. This approach opens up new possibilities for design innovation that could effectively tackle escalating consumption, especially in fast growing sectors such as consumer electronics goods.

2.0 Consumer electronics

This sector is of particular interest when discussing sustainable consumption. Consumer electronics now encompass a diverse and growing range of goods - from PCs to "throwaway" electric toothbrushes. Particular attributes of this sector include:

- Technological innovation, the proliferation of electronic communication networks and the dramatic reductions in cost drive consumption in this fast moving sector.
- There is a strong correlation between product lifespans and technological change (OECD, 2002)
- Consumers' perceptions have shifted from seeing such products not as durables but as consumables (Cooper & Mayers, 2000)
- Migration of electronics into new sectors: The increasing integration of electronics into traditional non-electrical goods. Everything from toothbrushes to pepper mills have now been transformed into electronic devices
- Novelty, fashion and short-term functionality are features of the increasing ephemeral nature of many of these products
- The DNA of consumer electronics, with their complex inventory of components, sub-assemblies and material alloys pose, at end-of-life, significant environmental impacts - far greater than many other categories of consumer goods

- Waste in this sector is growing - Each year 2 million working PCs are dumped in the UK (Wastewatch, 2005), a pattern that is increasingly mirrored worldwide as computer networks proliferate. In the UK alone 15 million mobile phones are discarded each year while only 4% are recycled (David, 2005)

3.0 The challenge for design

Designers have been identified as key stakeholder in determining product lifespans. This debate also highlights the limited power of designers to effect change (Cooper, 2005). Despite the many possible product lifespan strategies available, their effectiveness is unknown (van Ness, 2003). Even within the consumer electronic goods, there is a huge variation as to what may be an appropriate and effective response to product obsolescence. Of the strategies available, many may be rendered ineffective due to a range of behavioural and structural (systems) factors. Behavioural aspects of consumption are a particularly challenge and have been poorly understood by designers and advocates for sustainability (Jackson & Michaelis, 2004). The dynamics of markets and technology, the backbone of our consumption production economy, are equally inadequately dealt with. The consumer electronics sector, in particular, highlights the challenges for product lifespan strategies.

3.1 Technological change

Despite the environmental benefits that often result because of technological change, such change can also lead to significant levels of technological obsolescence. Product lifespan strategies are able to deal, to some extent, with technological change. However, where there are step changes in technology, for instance the migration from CRT (cathode ray tube) televisions and monitors to LCD (liquid crystal display), there is little incentive or desire to consider extending product life. Curiously, the market for LCD is about to make way for yet another technology, SED (surface-conduction electron-emitter display). The technology promises thinner screen panels, lower energy consumption than LCDs, and over time lower prices (SHM, 2006).

3.2 Competition, price and marketing

Cost factors, ownership, repair and replacement, are extremely important, if not the most singly important factor in determining product life (Bayus, 1988). Consumer electronics have experienced incessant price erosion for many years. The price ratio between costs of repair and cost of replacement has dramatically reversed over the last twenty years. For example, the replacement of a worn print head on a dot matrix printer was found to be more expensive than the replacement of the entire printer. Days to earn the cost of a TV set (based upon average gross weekly earnings) have dropped from 44 days in 1962 to 2.5 days in 2000 (ABN cited in Choice, 2001).

3.3 Rapidly emerging new markets

Put simply, demand overrides efficiency (Scherhorn, 2004). In the case of rapidly industrialising countries such as China and India, the demand for consumer goods overrides the likely effectiveness of product lifespan actions in mature markets. In mature and highly competitive markets advertising and marketing play an influential role in promoting consumption. Technical novelty is a hallmark of this sector.

3.4 Consumer behaviour

Human propensity for novel and new products is a function of meeting our social and psychological needs. The importance of the symbolic role of consumer goods, social and psychological identity, cultural and social values, institutional structures and dynamics of consumer lock-in are important but often poorly understood by product designers (Jackson & Michaelis, 2004).

3.5 Extend producer responsibility

Attempts to reduce the amount of electrical consumer goods waste through regulatory instruments, such as WEEE, have so far had little impact upon design. Delays in implementation and mixed messages from the UK government have only compounded confusion about WEEE, delaying opportunities for design (Hill, 2005).

4.0 Shifting priorities: materials not product lifespans

Many of the behavioural and systemic issues outlined above could also equally apply to other consumer product sectors. The enormity of many of these issues is a serious challenge for any product lifespan strategy to overcome. By considering, not just product lifespans but also material life (within products), many of these issues could be circumvented. Material lifespan strategies avoid direct confrontation with many of the socio/psychological and economic aspects of consumption - by maintaining materials in the consumption-production loop. The task shifts, from trying to engage with these complex matters that can undermine product lifespan strategies, to designing products that enable efficient and economic recovery of materials, components and/or sub-assemblies - at end-of-life. In fast moving consumer sectors, such as consumer electronics, this may be the most effective way to address consumption. If product materials can be efficiently and economically cycled back into the manufacturing stream then impacts could be minimised.

5.0 Beyond the recycling agenda

Much of what passes as recycling is essentially just capturing materials at end of life - little emphasis is placed upon re-use. The inefficiency and low quality of recovered materials prevents market pull for these recyclates back into the production stream (Hill, 2005). When these recyclates are redeployed back into the production stream they are often down-cycled into lower grade or inferior products. In their book *Cradle to Cradle,* William McDonough and Michael Braungart (2002) articulate a systems model of maintaining technical nutrients (materials) in a closed loop consumption-production economy. Technical nutrients are defined as synthetic materials (metals and polymers), which are the DNA of consumer electronic products. If recovery of materials is efficient and effective, resulting in high-grade of purity at competitive market prices, then they can be cycled back into the manufacturing stream without significant adjustment to the economics and logistics of manufacturing.

6.0 New opportunities

Design for material lifespans offers new opportunities for design innovation. With the currently evolving regulatory framework on extended producer responsibility (eg, WEEE) coupled with UK government targets on waste reduction, governance for material lifespan innovation is falling into place. Along with the shift of manufacturing to China, the UK product design sector has an opportunity to further redefine its relationship with industry. Many UK product design consultancies have already repositioned themselves, becoming far less concerned with issues of production and more with that of strategic marketing initiatives. As manufacturing continues to decline, design expertise could be developed in the emerging de-manufacturing sector. Product design has an important role to play in improving yields, purity and economic efficiency of materials (recovered from products). Some Japanese manufactures are gaining valuable experience in the design of products for de-manufacture by sending new products to recycling facilities. Information is fed back to the design teams to refine assembly and materials options (Envirowise, 2004).

6.1 Design strategies for material life

The table below summarises a range of strategies for material life.

Materials lifespan action		**Description**
Product design	• Material selection	Reduce mix of materials, avoid contamination Metals are more recyclable than polymers (Envirowise, 2004).
	• Product architecture	The arrangement and construction configuration can greatly enhance product disassembly. For instance, product construction based on matchbox or Chinese puzzle configurations, with sandwiched or rail mounted internal components enables quick and low cost disassembly.
	• Achilles heel	The incorporation of sacrificial bosses, screwdriver slots and break-away points can also greatly assist in the efficiency of product disassembly, reducing costs.
	• Fasteners	Standardise screw heads, avoid rivets, design accessible fastening points, consider use same materials as parts (Envirowise, 2004).
	• Part identification	Material type and date identification stamped into tool insert for plastic mouldings, (Envirowise, 2004). [see also RFID]
Active self-disassembly	• Shape memory materials	Products that self-disassemble could automate and lower de-manufacturing costs. Shape memory alloys (such as copper-zinc-aluminium Cu-Zn-Al) and polymers that react upon heating. These materials can be used at fasteners and actuators that react under certain stimuli. When heat and vibration is applied the fastener releases (Chiodo, et al, 2002).
Extended producer responsibility	• Regulations	A raft of EU regulations (WEEE, EuP, ELV, IPP) covering economic instruments, substance bans, voluntary agreements, environmental labelling and product design guidelines are planned to rollout over the next several years. Many of these regulatory instruments consider issues of product lifespan. WEEE, in particular, states recovery targets for percentage of weight per appliance and percentage of component and material reuse (Envirowise, 2004).
P.S.S. (Product Service Systems)	• Service / take-back agreements	PSS strategies offer service focused solutions, such as product-leasing or sharing arrangements that encourage businesses and manufacturers to supply products that are capable of long service life - optimal utilization (Van Hinte, 1997, Stahel, 2001, (Stahel & Jackson 1993, Manzini & Francois, 2003). Equally PSS strategies can successfully recapture products at end-of life. The design of the reverse logistics is integrated into the overall design of the PSS.
Product policy	• Warranty	After sales service and product warranties have an important role to play in determining product lifespans and the recapture of end-of life products and components.
Embedded intelligence	• Smart products	Smart products that carry on-board data and/or logger devices, can record information about: repair and upgradeability, product use, operation and upgradeability, Product DNA, construction, origin, disassembly, hazardous materials and toxicity, which can be useful at various stages throughout the entire life cycle (Ryan, 2004).

	• RFID	RFID technology can enable products to communicate specific information at end-of-life to aid efficient recovery of materials and components (Saar & Thomas 2002).
Marketing	• Public procurement	The public sector accounts for 16% of spending in the EU. If institutional purchasing criteria included product lifespans, and product take-back significant gains could be made in the field (OECD cited in Ryan, 2004).
Pricing	• Pay as you throw	"At present consumers are able to acquire and discard products relatively cheaply because the costs of waste disposal are externalised" (Cooper 2005) The Japanese Home Appliance Recycling Law (April, 2001) introduced charges for disposal. Hefty fines are imposed for non-compliance (Envirowise, 2004).
	• Deposit return	Economic incentives could encourage product recovery at end-of-life. A deposit paid at point of purchase could be refunded upon delivery to collection points.

7.0 Next steps

Working with de-manufacturing facilities and material technologists, the next phase of this research will focus upon selecting, refining and testing de-manufacturing design solutions. A range of design solutions design will be documented with the aim of assisting design teams to consider products beyond the life cycle. It is envisaged that rather than developing prescriptive strategies and methods for designers to design for material life, that a more tacit approach is developed - that is more likely to engage a design audience.

8.0 Conclusion

The complexity of technological change, consumer behaviour, markets and economic systems make current product lifespan actions unlikely to achieve widespread success. Designers have been identified as key in this debate but have limited power to effect change. By reframing product lifespans to also consider material life, new opportunities emerge for the designer. New alliances and expertise can be forged with the emergent de-manufacturing sector in the climate of increased regulation, shifts in global manufacturing and technological change. Design expertise in material lifespans works with rather than against patterns of consumption.

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