Product Life: Designing for Longer Lifespans

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[2.1]

Abstract

This Doctoral research investigates the role and potential of industrial design to confront product obsolescence in the consumer electronics sector. It investigates how design strategies can be developed to prolong the lifespans of products so to mitigate environmental impacts and contribute towards sustainable consumption.

The predominant response by industry and policy makers to environmental problems associated with consumer electronics has been through improved energy efficiency and, more recently, strategies to manage end-of-life waste. However, the volume and speed in which consumer electronics are produced, consumed and made obsolete remains unprecedented. Such circumstances can easily override and negate the effectiveness of efficiency and waste management responses. Moreover, as the lifespan for many of these products, notably personal computers and mobile phones gets shorter many consumer electronics products are still in functional order when disposed of. Product design, technological change, expanding digital infrastructure, replacement verses repair costs, the migration of electronics into new product sectors, in addition to our seemingly insatiable appetite for new and novel goods all contribute to reducing product lifespans.

This research investigates design strategies to prolong product lifespans. By investigating existing product features, user behaviours and societal factors lifespans strategies that can prolong product are identified. Three particular design strategies have been developed to explore this proposition - Piggybacking, Reassignment and Scripting.

Piggybacking specifically addresses products that are vulnerable to obsolescence from step changes in technology, such as the migration to digital technologies; while a Reassignment strategy is appropriate for products that susceptible to rapid technological change. On the other hand, Scripting is a framework strategy that can guide user behaviour to circumvent premature obsolescence by designing in 'scripts' within the product. These three strategies offer a new direction and opportunity for product innovation to tackle obsolescence in technological product sectors.

It is argued throughout this research that design practice can occur both formally and informally. Designers often establish the circumstances within a product that can lead to obsolescence, while it is the user who often determines actual product life. However, if a product can be adaptable for changing circumstances it is better able to avoid obsolescence. Industrial designers can enable user-adaptation of products through the design of open products. An open product delegates a role of design to the user thereby enabling a product to be adaptable to changing circumstances, prolonging its lifespan.

This research contributes new knowledge about product lifespans and design practice. It demonstrates the importance of user behaviour in determining product life by documenting many informal examples of prolonged product life. It applies new design strategies that can lead to new design innovation.

Acknowledgments

The advice I received while considering the prospect of doctoral research was to seek out the right supervisors and ensure a period of work/life stability. While I partially followed this advise by choosing knowledgeable and well-behaved supervisors, I set myself a considerable challenge by not only changing jobs but also moving to the other side of the planet! Despite such obstacles many people have helped me keep it on-track and assisted me in developing new skills and knowledge.

There are many people who I wish to thank. Firstly, my old work colleagues Ann Thorpe, Julian Lindley and Alastair Fuad-Luke, who, while at University for the Creative Arts we evolved a new and unique undergraduate programme combining product design and sustainability. Our many conversations assisted me enormously in developing a worthwhile research topic.

In specific regard to this thesis, I'd like to thank my supervisors Dr Paul Micklethwaite and Dr Tim Cooper and examiners Dr Tracy Bhamra and Philip Davies. Thanks also to John Gertsakis, Jake McLaren, Dr Steve Brodie and Ross Nicholls who have contributed in various and vital ways. And to the many other colleagues who have contributed to my broader understanding of the possibilities that design can offer, including Dr Tony Fry, who many years ago set me straight on the challenges facing design practice, and Dr Oya Demirbelik, who first encouraged me to give academic research a go.

Without supportive work environments, at University for the Creative Arts, UK, my former employer, and more recently at University of New South Wales, Australia, I would have found such an enterprise impossible in terms of time required and available resources.

And finally, thank you to my family Sally, Tim and Kit.

This work is dedicated to my wife Sally Kidall for her encouragement, patience and support.

Miles Park

September 2009

This thesis is set in Helvetica (over 50 years old but far from obsolete).

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PART 1: Introduction and Context

1_Introduction

The short lifespan of consumer products remains a relatively unattended problem compared with the many other environmental and social pressures highlighted in society today. Climate change, poverty and resource depletion are three particulars requiring urgent action. However, on closer inspection, these problems are all interdependent, as is the concern of this research into the lifespan of products. The volume and speed in which manufactured goods are produced, consumed and made obsolete remain unprecedented.

Of particular interest to this research is the consumer electronics sector. Since the advent of the mass-produced microprocessor and low-cost manufacturing, along with increasing affluence and aspiring ownership of more material goods, the consumption of consumer electronic products or EuPs (energy-using products) has escalated dramatically. What were formerly described as 'consumer durables', are now often regarded as 'consumables' (Cooper and Mayers 2000). The lifespan for many of these products, notably personal computers and mobile phones, is shortening (Babbitt et al. 2009; Hai-Yong and Schoenung 2006), with many still in functional order when discarded (van Nes 2003).

Consumer electronics, ranging from computers, televisions, cameras and phones to electronic toothbrushes and toasters have become embedded in many facets of our daily lives. It is hard to imagine life in contemporary society without them. We are so dependent on them that without them, life for many of us would become intolerable. But for many, especially in the developing world, ownership of these devices has been, until relatively recently, little more than a remote aspiration. However, this is rapidly changing with increasing availability and affordability. Many citizens in the developing world are now adopting the habits of the throwaway culture of the industrialised world. Global consumption of this magnitude poses some serious challenges on how to meet consumer demand while at the same time mitigate the consequential negative environmental and social impacts. These include, dwindling availability and equity of natural resource, anthropogenic greenhouse gas emissions, impacts on natural systems, exploitative working practices, and growing volumes of toxic electronic waste (e-waste) (UNEP 2006).

The short lifespan of consumer electronics encapsulates many of these complex problems. Despite these seemingly intractable problems, knowledge of the impacts linked to the short lifespan of consumer products remains mostly unrecognised and overlooked by environmental researchers and policy makers. Current knowledge on many aspects of the lifespan of products is inadequate (Cooper and Mayers 2000).

Industrial design is implicated as a root cause of product obsolescence (Margolin 1998). As a profession it first emerged in the United Sates during the Great Depression to recreate consumer demand for manufactured goods (Meikle 2001). It still remains a strategic tool for increasing product sales, by providing new and novel product designs. As well as creating desire for the new and novel, design can also be a catalyst for change to prolong product lifespans. Behind any manufactured product lies a process of conception, planning and implementation. This process inevitably involves designers, people who make decisions on the many parameters that can influence, lock-in or help determine a product's lifespan. However, design can also happen elsewhere. These informal and amateur design practices can have a significant influence on prolonging product life. They are often unexpected by design professionals and remain mostly unrecognised in design discourse.

This research considers opportunities for industrial design practice to engage and contribute knowledge to these emergent and increasingly important concerns. It identifies and applies product lifespans strategies to design projects to gain understanding of how design can mitigate product obsolescence.

1.1_Research aim, objectives and questions

This Doctoral research investigates the role and potential of industrial design to confront product obsolescence in consumer electronics sectors. What can be learnt from existing product examples and consumer behaviour that result in prolonging product lifespans and slowing obsolescence? By investigating existing product features, user behaviours and societal factors that can prolong product lifespans, specific examples are chosen and developed as design strategies and applied to product design projects. Central to this research is the consideration of design as a process. It seeks to understand how design can play a role in addressing product life. In doing so, the adopted research methodology contains practical design elements that can be described as 'research through designing'. These include, amongst others, the documenting of three of the author's own design projects in demonstrating and illustrating the theory discussed within this research.

Research Questions

Q1. What shapes the consumption and the obsolescence of products?

Q2. What can be learnt from existing examples of prolonged product lifespans?

Q3. Can specific examples of prolonged product lifespans be described and structured into formalised strategies.

Q4. Can product lifespan strategies be successfully applied to design projects?

Q5. Do product lifespans strategies offer opportunities for new design innovation to slow product obsolescence?

Questions 1 and 2 are considered in Part 1 of this thesis that includes Chapters 2 to 4. Chapters 2 to 4 present the literature review that locates this research in the range of relevant disciplinary contents. Questions 3 and 4 are addressed in Chapters 7 and 8; first by describing each selected strategy and then by documenting the research - through design methods applied to each strategy. Question 5 is reflective. It is explored through analysis of the research project findings and opens up into a discussion of themes and opportunities arising from the new knowledge emanating from this research. The table below maps the relationship between the research aim, objectives and research questions. [Refer to Figure 1]

Aim

To identify and develop understanding of strategies that can prolong the lifespans of products and thereby apply such strategies to structured design projects.

Objectives

1. Review the literature and locate the disciplinary contexts of product obsolescence.
2. Identify existing examples of prolonged product lifespans in the consumer electronics sector.
3. Organise specific product features, consumer behaviours and societal factors that can prolong product lifespans.
4. Select and apply specific lifespans strategies to structured design projects.
5. To contribute understanding of how design can prolong the lifespans of product in fast moving consumer sectors.

Aim	To identify and develop understanding of strategies that can prolong the lifespans of products and thereby apply such strategies to structured design projects.	
Objectives	**Research Questions**	**Research Action / Method**
1. Review the literature and locate the disciplinary contexts of product obsolescence.	Q1. What shapes the consumption and the obsolescence of products?	Literature review of multiple disciplinary fields including, social sciences, technology and design [Refer to Chapter 2 &3]
2. Identify existing examples of prolonged product lifespans in the consumer electronics sector.	Q2. What can be learnt from existing examples of prolonged product lifespans?	Literature review identifying existing examples of prolonged product lifespans [Refer to Chapter 4] Categorisation of examples prolonged lifespans [Refer to Section 4.1]
3. Organise specific product features, consumer behaviours and societal factors that can prolong product lifespans.	Q3. Can specific examples of prolonged product lifespans be described and structured into formalised strategies?	Identification, selection and description of specific strategies [Refer to Section 7.1] Using & Consuming research event [Refer to Chapter 6]
4. Select and apply specific lifespans strategies to structured design projects.	Q4. Can product lifespan strategies be successfully applied to design projects?	Selection and description of strategies - Piggybacking, Reassignment and Scripting [Refer to Chapter 7] Pilot design project with design students [Refer to Section 7.2] Design Projects - Piggybacking, Reassignment and Scripting [Refer to Chapter 8]
5. To contribute understanding of how design can prolong the lifespans of product in fast moving consumer sectors.	Q5. Do product lifespans strategies offer opportunities for new design innovation to slow product obsolescence?	Analysis and evaluation [Refer to Chapter 9]

Figure 1: Relationship between Aim, Objectives and Research questions

1.2_Thesis structure

This thesis commences with an examination of product obsolescence within the broader context of consumption. It explores the structural and socio/cultural motivations behind the 'throwaway society'. Product obsolescence is discussed with reference to its origins, terminology, typologies and its intertwined history with industrial design.

Examples that illustrate prolonged lifespans or defy obsolescence follows. They are organised into a three level structure: product (features), individual (behaviour) and societal (socio/economic). A noted feature of many of these examples is that many are informal and unplanned. Often they have evolved due to specific situations or individual circumstances.

From this review of examples three specific strategies are identified and selected as suitable to apply to formalised design projects. They have been chosen due to their potential value as strategies to be applied within a design process. Each design strategy is investigated through a structured design projects.

Design activities and projects undertaken as a part of this research include:
> A seminar activity with participants attending a sustainable design seminar.
> A pilot design product project undertaken by second year product design students.
> Three research-through-design projects undertaken by the author.
Figure 2 illustrates the research projects and their interrelationship discussed within this thesis.

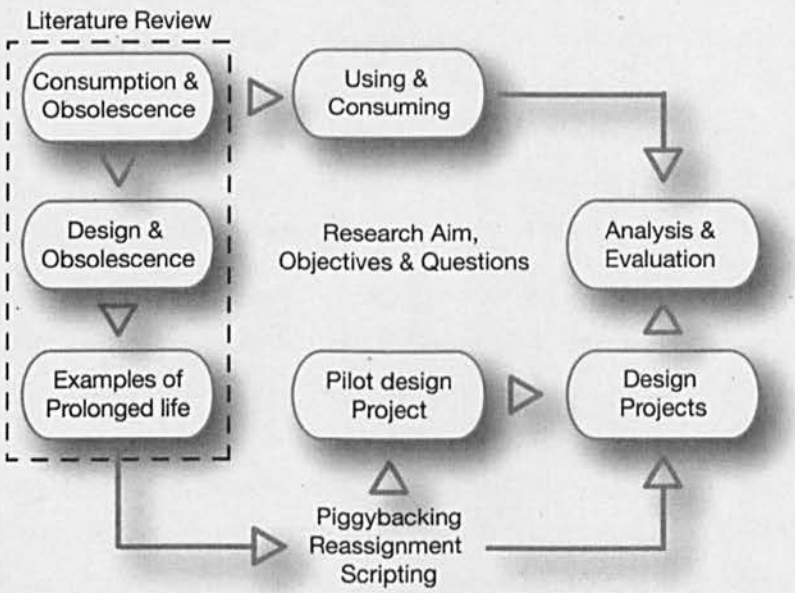

Figure 2: Project research map

An account of the adopted research perspective that underpins this research is offered in Chapter 5. A key feature of this is a research-through-design methodology. This involves the undertaking of product design projects applying three identified product lifespan strategies - Piggybacking, Reassignment and Scripting.

Chapters 6, 7 and 8 describe in detail the three research projects: a design activity with seminar participants, a pilot design project undertaken with product-design students and three design projects devised by the author. The concluding section of this thesis [Refer to Part 3] draws together all elements of this research. It discusses implications of the findings with reference to the literature in the field and the research questions and aims and objectives. Key and emergent themes are identified, and the implication of this research to design practice and further work in the field is proposed.

2_Consumption and Obsolescence

This and subsequent chapters in Part 1 of this document should be viewed combined with the literature review which positions this research. The literature review addresses the following research questions:

Q1. What shapes the consumption and the obsolescence of products?

Q2. What can be learnt from existing examples of prolonged product lifespans?

The devised objectives to meet this aim are:

> Review the literature and locate the disciplinary contexts of product obsolescence.

> Identify existing examples of prolonged product lifespans in the consumer electronics sector.

Figure 1 maps the relationship between the aim, objectives and research questions and their link to the literature review. [Refer to Figure 1]

This chapter establishes the context for this research into obsolescence and the lifespan of products. To develop an understanding of the lifespan of products it is important to start with a review of the sociological, economic and technological contexts that shape consumption practices and determine the lifespan of products. This background analysis offers a basis on which to understand to the complex underlying economic and socio/technical contexts into which design for product life-span strategy much acknowledge.

In order to address the research question the concept of sustainable consumption is first discussed leading into a review of the obsolescence of consumer electronics. Central to understanding what lies behind consumption is a survey of the social theory of consumption literature. It identifies underlying behavioural factors that shape consumption practices. [Refer to Figure 3] Terminology is introduced to position this research historically and relative to other literature in the field of product obsolescence. Definitions of 'absolute' and 'relative' obsolescence are considered highlighting the importance of the many subtle forms of socio/technical dimensions behind product obsolescence. Discussion ensues, focusing on the consumer electronics - a sector that is prone to product obsolescence.

There exists, since its origins as a profession, a strong link between industrial design and obsolescence. Chapter 3 explores this interwoven history in detail by focusing upon the evolving role of design practice. It lays the foundations for

subsequent research in this thesis on how design practices can be redirected to design for prolonged product lifespans.

Figure 3: Billy Hibble never threw anything away [photo: Jeremy Park]

2.1_Sustainable consumption

Research into product lifespans is interrelated to a wider debate on understanding on how society can produce and consume more sustainably. Sustainable consumption can be defined as, 'the consumption of goods and services that meet basic needs and quality of life without jeopardising the needs of future generations' (OECD 2002: 16). Whether this means consuming differently or consuming less is uncertain. However, central to this understanding is the general agreement that the throughput of resources in the economy must be reduced and better used for all. At the macro level, this will require a transition from a linear economy [Refer to Figure 4], where inefficiencies and wastes are built into the system, to a cyclic or circular economy, involving an efficient and effective recapture and redeploying of wastes and resources back into production-consumption streams (McDonough and Braungart 2002; Pearce and Barbier 2000).

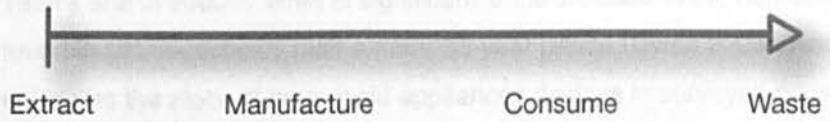

Figure 4: Linear model of the economy

Such an approach increases resource efficiency by reducing demand for raw materials and by making greater use of post-consumption waste. Embedded in this imperative for resource reduction and efficiency is the role for other allied strategies, including slowing the rate of obsolescence in manufactured products. It is within this field that this research, into the twinned themes of product obsolescence and product lifespans, seeks to make a contribution.

Research into product lifespans has in the past received relatively little interest (Cooper 2004) as evident by the lack of empirical studies. However, this may be set to change as consumption is now on many government and Intergovernmental organisations agendas (NCC 2006; OECD 2002). The UK government has, for instance, produced a succession of reports including Securing The Future, which devotes a whole chapter to sustainable production and consumption. The report makes explicit reference to the role of product design in addressing unsustainable consumption (DEFRA 2005).

2.2_Consumer electronics

Obsolescence in the consumer electronics sector is of particular interest in this research because of the magnitude and increasing growth in the sector. Allied to this growth is the diminishing lifespan for many of these products. Technological change, the proliferation of electronic devices, expanding communications networks and the dramatic purchasing-cost reductions all contribute to escalating consumption in the sector. Because of this, consumer perceptions have shifted; many of these products are no longer seen as durables but as consumables (Cooper and Mayers 2000).

2.3_Rise of the machines

Consumer electronics as defined in this research embraces a wider range of household energy-using Products (EuPs). To illustrate the diversity and number of products that can be included within this definition, the following table [Refer to Figure 5] contrasts the number of appliances typically found in UK households in

1970's and in 2000's. What is significant is the increase in the numbers of devices found in UK households over a mere 35-year period (Owen 2006). Another study estimates the stock of household appliances devices in surveyed households has increased around 60 per cent in the last five years. The same study found that most of these products were relatively young, with most being less than 10 years old (Cooper and Mayers 2000: 3).

1970's	2000's	
Television	Televisions	Microwave
Vacuum cleaner	Video players	Electric oven
Electric bar heaters	DVD player/recorder	Electric hob
Hi-fi music system	Portable music players	Extractor fan
Hairdryer	Mobile phones	Large fridge/freezer
Electric kettle	Hairdryers	Drinks cooler
Washing machine	Hair irons	Portable fan
Iron	Electric toothbrushes	Vacuum cleaner
Electric blanket	Wireless telephone	PC computer
Radio	Answering machine	Monitor
Sewing machine	Slave portable phone	Printer
Cooker	Electric kettle	Scanner/fax
Cassette player	Smoothie maker	Digital camera
Fridge	Magimix	Set-top box
DIY appliance	Ice-cream maker	Electric shaver
Toaster	Digital radio	Steam iron
Occasional lamps	Mini hi-fi systems	Juicer
	Washing machine	Home security system
	Tumble dryer	Broadband connection
	Dishwasher	Halogen bulb light fittings
	PlayStation/games console	Personal care products
	Cappuccino maker	Power tools
	Digital clock/radios	Electric blanket
	Electric lawnmower	Strimmer

Figure 5: Typical appliances owned by households in the UK in 1970's and in 2000's[1] (Owen 2006: 9)

The growing number and lifespan of EuP's entering and leaving our homes continues to hasten. However, accurate data on the consumption of specific consumer products is hard to find. It "is the most under-represented sector in terms of data and information held. It is also the fastest-moving sector, which makes it very difficult to monitor and forecast" (Owen 2006: 21). Market monitoring of retail sales and forecast shipments of consumer electronics offers a means of assessing consumption in the sector. According to data amassed from 140,000 retail outlets, an international market research firm, GfK Group, forecasts that global demand for consumer electronics in 2008 was expected to grow to $US618.6 billion - equivalent to the GDP of the Netherlands, or $US100 spent for each person on the planet (GfK Group cited in The Guardian newspaper 2007).

[1] Figure for 2000's derived from 2002 data

Despite the global economic slowdown being experienced in world markets in 2008, GfK still predicted that growth would exceed 8 per cent for the year. It predicted 63 per cent of the growth would be accounted for by flat-screen TVs, laptop computers and mobile phones alone (GfK Group 2007). With the unfolding economic circumstances of worldwide economic recession ,it is unlikely that such an optimistic forecast will be realised. Yet, despite the downturn, the sector continues to grow.

2.3.1_Ephemeral electronics

In 2006, there were more than 1 billion mobile handsets in use around the world (Canning 2006) with the average European changing his or her phone every 18-24 months. Personal computer shipments in Europe increased 24.3 per cent in 2007-08 (Gartner 2008) with the average lifespan of a computer changing from 4-6 years in 1997 to only two years in 2005 (Hai Yong and Schoenung 2006). It is estimated that 20-50 million tonnes of waste electrical and electronic equipment (WEEE) is thrown away worldwide every year (UNEP 2006). Each year, 2 million working PCs are dumped in UK landfill sites (Waste Watch 2007), while in the US, a staggering 14-20 million obsolete PCs, often still functional, are condemned as e-waste (UNEP 2006). Regrettably, recycling consumer electronics remains a fringe activity. Of the 15 million mobile phones discarded every year in the UK, only 4 per cent are recycled (Adam 2005). The volume of e-waste is growing, and is expected to increase 3-5 per cent a year, with developing countries increasingly contributing to this total. They are expected to triple their output of e-waste by 2010 (UNEP 2006).

2.3.2_Technological change

A strong correlation exists between product lifespans and technological change (OECD 2002). This is particularly evident with consumer electronics where there is a tendency for technology push (now we have it, let's do something with it). Moore's Law offers a dramatic illustration of the rate of technological change. Moore observed that electronic integrated circuitry increases in complexity relative to cost at a rate of roughly a factor of two every year (Moore 1965 cited in Slade 2006). This observation, first made in 1965, still holds authenticity today. The implication of this is especially startling when a comparison is made between computers and automobiles.

> *"If the automobile industry had made as much progress in the past 50 years, a car today would cost a hundredth of a cent and go faster than the speed of light"* (Kurzweil cited in Slade 2006: 197).

Despite the environmental benefits that often result from technological change, such as energy efficiency and a reduction of toxic substances, rapid technological change leads to significant levels of obsolescence and waste. Where a radical development trajectory or step-change technological development occurs - as in the consumer electronics sector - there is often little consumer incentive or desire to consider extending the lifespan of an technologically obsolete product. The consumer electronics sector is plagued with examples of technological obsolescence - from VCR (video cassette recorder) to DVD (digital video disc), and analogue to digital broadcasting services to name just a few recent step changes in technology. In such cases, consumers who fail to renew their consumer electronics devices are eventually locked out and prevented from playing or accessing the availability of new media content.

2.3.3_Migration to new devices

Over the last 20 years or so, electronics have migrated into new product areas that traditionally have been dominated by mechanical or manually operated devices. The most evident examples of this migration include products for the kitchen (such as bread makers and electronic pepper mills), personal hygiene devices (electric toothbrushes and feminine razors), children's toys (electronic games and illuminated balls) and portable novelty gadgets (electronic key rings and motorised desktop accessories). Some of the more bizarre examples include electronic vibrating soap and battery-illuminated sweets. Vibrating soap consists of a disposable motor and battery assembly within a cake of soap that vibrates during use (IWOOT 2006). Lighting Bugs, an electrically illuminated confectionery, consists of a pair of disposable tongs containing a battery and LED (light-emitting diode) used to pick up a translucent winegum sweet shaped like a bug (Kandy Kastle 2006). [Refer to Figure 6] The functional lifespan of this throwaway electrical device is only as long as it takes to consume the packet of sweets. Disposable electronics are also finding their way into packaging. NXT Light, a skincare product aimed at 18-24-year-old men, contains a LED powered by three AA batteries. The product is designed to flash, illuminating the contents of the product while on retail shelves for up to a year (NXT 2008).

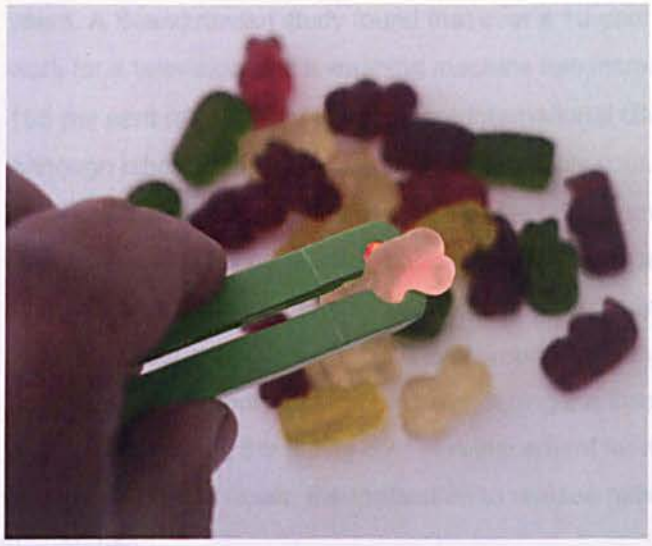

Figure 6: Ephemeral electronics: Lighting Bugs, electrically illuminated confectionery [photo: author]

2.3.4_Cost of ownership

Consumer electronics have been subject to incessant price erosion over many years. In real terms, adjusted for average earnings, consumer electronics have become increasingly affordable. The number of days required to earn the cost of a television (based upon average gross weekly earnings) has dropped dramatically since television was first introduced in the 1960s, likewise for many other household products such as toasters, irons and portable radios. UK statistics offer a similar picture; £100 of audio video equipment bought in 1987 would cost only £15 in 2007 (National Statistics 2008). Manufacturing costs for such items have been falling for many years. A combination of factors including the wide availability of low-cost mass-produced microprocessors, production automation, the shift to manufacturing in low-cost labour centres and production supply-chain efficiencies all conspire to the falling cost of many consumer electronics items. Also, time-compression product development technologies such as, computer-aided design (CAD) and rapid prototyping coupled with lean production processes - such as concurrent engineering, value engineering and just in time (JIT) - afford significant time and cost savings (Hopkinson and Dickens 2006). These deflationary trends can bring new material benefits to those who could not previously afford such 'luxuries'. Increasing affordability is 'democratising consumption' (Linstead et al, 2003) especially in developing countries, where the pursuit of material wealth is mirroring that of the west.

Cost of ownership extends much further than simply purchase price. The ratio between cost of repair and cost of replacement has dramatically reversed in recent

years. A Scandinavian study found that over a 10-year period, the cost of repair work for a television and a washing machine has increased by 150 per cent and 165 per cent respectively (Consumers International cited in Cooper 2005). Although labour is a significant component of this cost, even repair work by the owner may be uneconomical because of the cost or unavailability of parts. In many instances, parts will be unavailable because of the incessant rollout of new models. The inventory of spare parts for each successive model becomes increasingly complex and expensive to stock. It is claimed that the purchasing cost is possibly the single most important factor in determining the lifespans of a product (Bayus 1988). Considering the falling cost of replacement for many EuPs and the increasing cost of repair, the motivation to replace rather than prolong a product is heightened.

2.3.5_E-waste

The DNA of consumer electronics, with their complex inventory of components, sub-assemblies and material alloys, can result in a significant environmental impact throughout their lifecycles. It can be far greater than for many other categories of consumer goods (Ryan 2004). The manufacture of consumer electronics involves many toxic or scarce substances such as mercury, cadmium, lead and copper. The manufacturing processes are also extremely energy-intensive. Compared with injection moulding, a typical manufacturing process encountered with the production of many products, the production of PCBs (printed circuit board) and electronic components for consumer electronics requires significantly greater energy inputs (Gutowski, et al. 2006).

The consumption phase brings other problems, the most significant being CO_2 emissions from the use of fossil fuels in electrical power generation. Further problems arise when a product reaches the end of its life and enter the waste stream. These include potentially toxic or valuable materials 'lost' in landfill or through incineration. This particular problem is of increasing concern as the volume of e-waste generated has grown dramatically in recent years. The problem has not gone unrecognised.

Figure 7: WEEE Man represents the amount of waste electrical and electronic products that an average UK citizen will throw away in a lifetime [photo: author]

An attempt to reduce the amount of toxic waste from electrical consumer goods is being tackled through regulatory instruments such as the European WEEE (waste electrical and electronic equipment) [Refer to Figure 6] and RoHS (restriction of the use of certain hazardous substances in electrical and electronic equipment). The EU WEEE Directive sets out recovery and recycling criteria applying within the 10 product categories. [Refer to Figure 8]

Large household appliances	Electrical and electronic tools
Small household appliances	Toys leisure and sports equipment
IT & Telecommunications equipment	Medical devices
Consumer equipment	Monitoring and control instruments
Lighting equipment	Automatic dispensers

Figure 8: EU WEEE product categories (BERR 2007: 2)

In the face of escalating consumption and declining product lifespans the directive is timely but has so far struggled to make any measurable impact. Initial delays in implementation and mixed messages from government have compounded confusion about the legislation stalling opportunities to tackle these issues (Hill and Shaw 2005). Meanwhile in many other parts of the world, the e-waste problem remains a low priority for governments.

Alongside the many environmental impacts associated with the consumption of consumer electronics there is also hidden social costs (Datschefski 2001). Exploitative and dangerous work practices occur at various stages during a product's lifecycle. These include impacts on communities during the extraction of raw materials, exploitative work conditions and ultimately illegal processing of e-waste in developing countries that for so long have avoided public scrutiny (Grossman 2006).

2.4_The throwaway society

We live in a throw-away society; much of what we buy is soon thrown away (Slade 2006). While food and packaging waste are typical candidates for scrutiny, more insidious so-called 'consumer durables' increasingly entering waste streams deserve closer attention. Obsolete electrical and electronic products, often referred to as e-waste, are the fastest growing category of waste in the EU. It is growing at about three times the rate of normal municipal solid waste (Darby and Obara 2005).

Figure 9: Virgin Mobile, encouraging subscribers to destroy their mobile handset to justify an upgrade to a new one. [www.virgin.com.au]

Why do we consume the way we do? Much has been written and documented about and how people consume, but more needs to be done on why we acquire and consume new consumer goods. One of the few qualitative studies available investigating the purchase, use and disposal of household products (Cooper and Mayers 2000) found that the main disadvantage of buying longer lasting products was not that they would break down, but that they would become out of date. Such a finding is supported by other social sciences literature confirming there are other

strong sociological and psychological motivations shaping our attitudes and behaviour towards consuming and disposing of products.

> *Social theories of consumption have revolved around a number of central problems including the emergence of consumer society, the relation between consumption and production and the symbolic role of consumer goods (Shove 2006: 293).*

Tim Jackson (2006), a professor in sustainable consumption, offers a useful roundup of key texts on consumption. He suggests a closer look at the literature from disciplines as diverse as consumer research, psychology, sociology, social philosophy, anthropology, and economics is required to gain a meaningful understanding of the complex debates concerning consumption. The task of mapping the many diverse conceptions of consumer behaviour is challenging. The literature on consumption is remarkable because of the many different approaches, disciplinary assumptions, underlying values and different models of the ways in which consumers behave. At one extreme we have writers advocating voluntary simplicity by rejecting consumption for the 'good life' (Elgin 2003) while at the other extreme, the literature on rational economics argues that when the market works efficiently, consumers at any one time will make rational (and sustainable) choices. However, despite such a multiplicity of perspectives, a defining feature of the sociological debates on consumption is that it is socially constructed (Jackson 2006). This goes some way to helping explain why product obsolescence is much more complex than simply considering the problem of when a product breaks down. Specifically for this purpose of understanding the lifespan of products and why they become obsolete, the following section reviews relevant aspects on the social construction of consumption. They can be summarised as:

1. Social Comparison
2. Matching 'Diderot Effect'
3. The Creation of Self-identity
4. Mental Stimulation / Novelty

2.5_The social construction of consumption

In 1899, Thorstein Veblen observed of middle-class America that consumption was used to help gain and signal status. He coined the still-often heard phrase 'conspicuous consumption' to describe the way people would seek to impress others and to gain advantage by the conspicuous (and often wasteful) consumption of goods and services (Veblen 1994). By mid-20th century the advertising slogan 'keeping up with the Joneses' appeared as a reformulation of Veblen's social

comparison. It clearly implies the importance that consumer goods play in signalling social comparison with others. A more contemporary analysis is offered by Fred Hirsch (1977) who uses the term 'positional goods' in discussing how consumer goods can be used, not just for their functional value but also their social value, to establish a pecking order with respect to others.

This social value is symbolic and can also be used to create self-identity to transmit messages to others. There are few better examples of the role of symbolic value than the rituals of individual display concerning mobile phones. For instance, ownership of the new Apple iphone is often more than just being able to make and receive phone calls, email and web pages. The process of self-identity is dynamic as it relies on the symbol possessor (a person desiring to express his or her identity to others) and a symbol observer (the person to whom the symbol possessor wishes to communicate his or her identity) (Hirschman 1980 cited in Jackson 2004). Thus, people manage and manipulate these messages to create self-identity in a continual process of constructing and reconstructing identity within in a universe of social and cultural symbols (Jackson 2004). As with the fluidity of constructing and reconstruction of self-identity, so too it is with the desire for the new and novel.

> *"While technological innovation and planned obsolescence both have a part to play in keeping consumption levels high, the greatest contribution is consumers' almost magical ability to produce new wants immediately after old ones have been satisfied"*(Campbell, 2006).

Campbell argues that those people with a preference for novel goods and services contribute most to the dynamic nature of modern consumption. Novel goods are defined as not just the new, but also the unfamiliar. This is true with many new consumer electronic products where the consumer many not be familiar with a precise product or the mysteries of the internal workings, but familiar enough with the promised function it is designed to fulfil (Campbell 1992). The psychological pressures used by marketers to exploit our anxieties about social comparison (with others) and our desire for a 'self completion' (Hamilton and Denniss 2005: 17) to align our actual selves with who we wish to be, are powerful motivators driving consumption practices.

The inexhaustible desire for the new and novel has been described as a social pathology (Jackson 2004) where wants are inexhaustible. Once a novel product is consumed, novelty is virtually exhausted as the unfamiliar becoming the familiar. This is often the case with fashion where novelty is constantly reinvented, creating a sequence of continuous wants (Campbell 1992). For many people, this is

expressed by the leisure activity of shopping. The experience of new and novel attractions alleviates boredom and satisfies psychological needs for the new and novel.

The sequence of acquisition can be set off when existing 'old' goods are juxtaposed against the new and the novel. Described as the 'Diderot Effect' (McCracken 1990: 118) after the French philosopher of the Enlightenment of the same name. He described when, in receipt of a new red gown, how it made other items in his study look shabby. This matching or Diderot Effect is based on the notion that certain consumer goods go together. For instance, a Rolex watch with a new BMW car reinforces the social significance of each item. The significance of this observation in terms of product lifespans is that when one item fails to complement another, it may be replaced in a cycle of acquisition. This can propagate in an ongoing process of 'ratcheting' (Shove 2003) where the replacement of one product sets off another round of acquisition.

To this list above we could add many other socio/economic criteria that help explain consumption and the lifespan of product. However, this brief account of sociological and psychological dimensions attempts to illustrate the importance of factors - other than those attributed to economics or technological change - to help explain why we consume the way we do. As will discuss in the following section, obsolescence is often relative and not absolute in that product failure is only one competing dimension that can determine a product's lifespan.

2.6_The language of product lifespans

Many terms and definitions have been used in association when discussing the lifespan of a product[2]. The term 'product lifespan' is used within this research to denote the time between first acquisition and the ultimate disposal of a product. It is not to be confused with the marketing use of the term with reference to market lifespan (market availability) of a product. A product's lifespan is the totality of its duration of use despite possible changing owners or users, context and possible uses it may be subjected too. A product may also be acquired and disposed of many times during its lifetime. This term is preferred as it denotes a neutral stance. It suggests neither a preference for an extension or shortening of product life.

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[2] Nicole van Nes uses the term product lifetime offers an equally valid definition: 'The product lifetime is the duration of the life of a product, starting from acquisition (new or second hand) and ending at the moment of replacement' (2003).

A closely associated term is product obsolescence. A product is determined to become obsolete when it no longer fulfils a symbolic or functional role. Product obsolescence first rose in public prominence with the idea that manufacturers 'planned obsolescence' to boost sales. This could be achieved by changing a product technically or stylistically by marketing goods with reduced durability or subject to successive stylistic changes. A further account of the terminology surrounding obsolescence is discussed in the section below [Refer to Section 2.6.1] See also Chapter 3 for a discussion of the evolution of product obsolescence and its entwined relationship with Industrial design.

Durability (Stahel and Jackson 1993) is another term that appears in the literature on product obsolescence. It implies notions of permanence and longevity. If a product is durable it is often thought to be reliable, rugged and generally resistant to wear and tear. Thus the term 'consumer durables' implies a relatively long-lasting product that can be maintained or repaired and will not prematurely breakdown. Curiously when 'durability' is paired with 'emotional' - as with the concept of 'emotionally durable design' (Chapman 2005) - the term takes on a modified and extended meaning. Emotional durability implies a developing product-person relationship (Mugge et al. 2005), a form of psychological durability. As it seeks to explain factors leading to the various forms of relative obsolescence, beyond the physical and functional constraints that determine 'absolute' product lifespans. [Refer to Section 2.6.1] A product-person relationship is said to change over time. When a product is new, 'feelings' towards a product are high. As time passes, these feelings subside unless an attachment, memories and enjoyment (of the product are maintained) (Schifferstein, and Zwartkruis-Pelgrim 2008)

Similarly, the terms 'longevity' (Cooper 2005; Park 2003), 'product-life extension' (Heiskanen 1996) and 'product endurance' (van Hinte 1997) suggest prolonging product lifespans through resilience to the various forms of absolute and relative obsolescence. These terms imply that the objective is to extend product lifespans. However, strategies designed to increase product life may be simplistic and potentially inappropriate (Burns 2003). Lifespan or lifetime optimisation (Chalkley, et al. 2003) refers to the proposition that the objective should not be perpetual durability or endurance of a product, but rather that a product's lifespan should be optimised. This is of particular interest for energy-using products (EuPs) where the usage phase of the product lifecycle can consume considerable resources, mostly in the form of electrical energy.

A summary of terms is offered in below:

Product Durability	Product Longevity	Emotional Durability
Product Life-extension	Product Life-span	Product life-expectancy
Life-time Optimisation		

The UK Radio, Electrical and Television Retailers Association (RETRA 2008) take a different approach when suggesting product life expectancy. It frames product lifespans purely in terms of economy, cost of repair and availability of parts. Its code of practice suggests a washing machine should reasonably last 4-8 years. It defines life expectancy as:

> *" ..... the length of time a product would reasonably be expected to be able to be economically repaired where the spare parts are available. Some cosmetic parts may not be available for the same period of time as functional parts. It does not imply that goods should last for a given period of time without going wrong or that the repairer should not make a reasonable charge for a repair"* (RETRA: Code of Practice 2008: *online*)

2.6.1_Typology of obsolescence

Although product obsolescence had first been discussed during the depression of 1929[3] (Slade 2006) it was Vance Packard in his popular book *The Waste Makers* (Packard1963) who was the first to attempt a critical analysis of obsolescence. He suggested that manufacturers and retailers conspire to creating a state of planned psychological obsolescence to entice consumers to renew their possessions. He observed that planned obsolescence resulted in products becoming obsolete because of loss of function, poor quality or consumers' desire for something new. He devised that planned obsolescence can occur in three different ways:

> *"Obsolescence of function: In this situation an existing product becomes outmoded when a product is introduced that performs the function better. Obsolescence of quality: Here, when it is planned, a product breaks down or wears out at a given time, usually not too distant.*

[3] As early as 1928 Paul M Mazur, an investment banker with the now bankrupt Lehman brothers, is credited as the first to put forward the proposition of 'psychological obsolescence'. He declared, "Wear alone . . . [is] too slow for the needs of American industry" (Muzur cited in Slade 2006). Others at a similar time also picked up on this theme; refer to Chapter 3 for a further account on obsolescence during this period.

> *Obsolescence of desirability: In this situation a product that is still sound in terms of quality or performance becomes 'worn out' in our minds because a styling or other change makes it seems less desirable".* (Packard 1963: 54-55)

While he accepted that functional obsolescence was 'laudable' when planned, whereby a product becomes obsolete through incremental functional improvements. His criticism was reserved for 'obsolescence of quality', (where a product is designed to wear out quickly) and 'obsolescence of desirability' (what he termed as 'physiological obsolescence'), when 'a product becomes 'worn out' in our minds' (Packard 1963).

Meanwhile, he popularised another popular catchphrase, the 'throwaway society', a term that still maintains as much currency today (Cooper 2005). He stressed the importance of how consumer psychology could be shaped to perceive a product as obsolete and to establish (in the consumer) a desire for its replacement, despite its apparent functional condition. With the growing volume of discarded but still functional products, Packard's observations of perceived or relative obsolescence still resonate with some relevance.

Contemporary literature builds a more scholarly analysis upon this basic premise that obsolescence is planned. However, obsolescence can occur because of many other indirect and unplanned reasons. Since Packard's attack on planned obsolescence, the debate has shifted towards a deeper analysis of the various qualities that determine obsolescence. Granberg makes a useful distinction between:

> Absolute obsolescence

> Relative obsolescence (Granberg 1997 cited in Cooper 2004)

Absolute obsolescence is determined by the intrinsic quality of a product to resist wear and tear, degradation of materials, manufacturing consistency and factors relating to maintenance. Absolute obsolescence is often perceived as the most common type of product obsolescence as it is associated with the pervasiveness of low-cost and poorly designed goods that deteriorate quickly and breakdown prematurely. On the other hand, 'relative' obsolescence is a more complex combination of functional (technological change and changing needs) and socio-psychological (status, self-identity, fashion) factors. European statistics confirm that relative obsolescence is significant. Many products when discarded still function, 25 per cent of vacuum cleaners, 60 per cent of sound systems (stereos) and up to 90 per cent of computers are still in functional order when discarded (van Hinte 1997: 19). A UK survey on DVD players found that after six years, there was a

breakdown rate of only 4 per cent (Which 2006). The demise of electrical repair shops can be partly attributed to the increasing functional reliability of many such products. In instances where a functional product is discarded, obsolescence is 'relative' or 'perceived' as its lifespan is determined by factors other than (absolute) function.

On noting the trend of shortening lifespans of consumer durables, Kostecki (cited in Cooper 2004) proposes the determinants for marketing product durability. His typology for durability consists of:

1. Functional (in relation to products)
2. Economic (cost/performance competitor comparison)
3. Symbolic criteria (ability to meet abstract needs of the consumer). (Kostecki 1998 cited in Cooper 2004)

Within this typology is explicit reference to economic determinants of obsolescence. With respect to consumer electronics, this is an important observation as cost of repair, replacement and energy consumption (during use) can have a significant influence on determining a product life.

From a limited review of the literature from the 1990s, van Nes (2003) formulates a typology on what she refers to as 'replacement decision process' based on three categories:

1. Product characteristics: refers to aspects that provide added value of one product over another
2. Situational characteristics or external influence: which include factors external to the product
3. Consumer characteristics: refers to differences between people and how they make different choices when faced with similar situation

Cooper (2004) offers the most comprehensive summary and analysis of product obsolescence typologies. While acknowledging the continuation of planned obsolescence practices (absolute obsolescence) driven by manufacturers' cost reductions to meet competitive price points (Cooper 2005), his empirical research model draws on Granberg's typology of absolute obsolescence and relative obsolescence. Cooper defines relative obsolescence as having the following three conceptual categories:

1. Psychological obsolescence (mind)
2. Economic obsolescence (money)
3. Technological obsolescence (matter)

Psychological obsolescence taps into many of the complex and interwoven sociological and psychological aspects that shape consumer behaviour. Economic obsolescence is when financial factors intervene and we no longer want to keep or repair a product, or are induced through price incentives to replace it. Technological obsolescence occurs when existing products become (relatively) inferior to a newer product. The value in this model is that it has been developed through an empirical study into consumer attitudes to product obsolescence (Cooper and Mayers 2000).

A five-year EPSRC- (Engineering and Physical Sciences Research Council) funded project entitled *Network on Product Life-Spans* has advanced interest into researching the field. However, when the funded project was completed, it was reported that 'further work on typology and terminology is still needed to capture people's imagination, develop concepts and describe phenomena' (Cooper 2008).

2.6.2_Environmental obsolescence

One particular form of obsolescence that is increasingly important is 'environmental obsolescence'. This is a particularly noteworthy issue when discussing the lifespan of consumer electronics. Within her typology on replacement decisions, van Nes identifies a 'product characteristic determinant' for obsolescence, which she refers to as 'ecological profitability' (van Nes 2003: 55). This is said to occur when a new more eco-efficient product could potentially replace an older less environmentally efficient product. The observation is made that ecological profitability often goes hand-in-hand with economic obsolescence based on the assumption that a more energy-efficient product will be cheaper to run than an older, less energy-efficient product. To quantify this assertion for the optimum 'ecological' lifespan of EuPs, an 'eco-payback' formula is devised to show when a product should be retired. It compares the eco-efficiency of new and old products to determine the optimal time to replace an old product.

This recently identified 'environmental obsolescence' also appears in another PhD study by Anne Marie Chalkey, who investigates the environmentally optimum lifespan of electrical household products. Her study concluded the optimum lifespan of a dishwasher to be 8.1 years, after which it is environmentally beneficial to replace it with a more technologically advanced eco-efficient model (Chalkley et al. 2003). Both van Nes's and Chalkley's studies conclude it is beneficial to retire older EuPs for newer more eco-efficient ones.

However, does creating new demand for eco-efficient products create other, perhaps greater, environmental impacts? In purely technological terms, lifetime optimisation analysis may be able to determine a 'correct' product lifespan. However, when other factors are accounted for, including actual consumer behaviour (the way products are really used), entire lifecycle impacts of a product and the increased demand created for new eco-efficient products, lifetime optimisation calculations present an incomplete and inaccurate measure of environmental loads.

To illustrate one scenario, a new energy-efficient washing machine may only consume 0.3kWh of electricity per wash compared with 1kWh for an older machine. Based on 270 wash cycles, typical for a UK home[4], this would only represent a saving of £8 of electricity a year (Goodall 2007). If an older, less-efficient washing machine is used only intermittently over an extended period (well below the UK average) it would make little sense on either environmental or economic grounds to replace it. However, the prevailing belief by government regulators and many consumers is that the consumption of eco-efficient products should be encouraged. Energy labelling schemes are increasingly seen on many EuPs, reinforcing an agenda of environmental obsolescence. [Refer to Section 3.4.2]

2.6.3_Efficiency and obsolescence

The energy efficiency of UK domestic household appliances has improved 2 per cent a year since 1970 (Owen 2006). However, total energy consumed by domestic household appliances had doubled over the same period, representing a growing portion of total household energy consumption (BERR 2007). Growth in product consumption is reflected in the growth of household energy use, illustrating the cumulative effects of consumption and how 'demand can override efficiency' (Scherhorn 2004). On its own, further increases in the energy efficiency of consumer electronics are unlikely to make any significant impact in terms of reducing cumulative household energy demand or the consumption of consumer electronics.

[4] The number of wash cycles is based upon assumptions and not actual usage (Fawcett et al. cited in MTP 2008).

Two other issues further compound the situation of diminishing returns when considering efficiency. First, as a product becomes more energy-efficient through succession of redesigns and technological improvements, it becomes increasingly harder to achieve further gains in efficiency. Second, improved product energy-efficiency can backfire and encourage a change of user behavioural. The intended energy savings designed into the product can rebound[5]. These 'rebound effects' are important but are difficult to quantify (Sorrell 2007). Currently, there has been little research conducted on understanding how significant these rebound effects really are.

[5] Rebound effect occurs where 'designed in' energy and material savings of a product results in an actual increase in resource and energy consumption. It can be loosely defined as the difference between the projected and actual savings (or losses) due to increased efficiency. Economists first coined the term while studying market dynamics in the energy sector during the 1980s (Khazzoom, cited in Greening et al, 2000, p 390). Rebound effects may be categorized as consisting of direct, indirect and macro-economic effects.

3_ Industrial design and obsolescence – a shared history

This chapter investigates the origins and evolving role of industrial design[6] and its interrelationship with product obsolescence by looking at the literature on the history of design, and critiques of design and consumption. It starts with an historical overview of the evolution of the profession of industrial design and its co-dependency on industrial production in the design of new product forms. At a similar time, a parallel history of obsolescence also starts to emerge. Discussion related to industrial design shows how design is clearly implicated in creating fertile circumstances for product obsolescence to develop.

Alternative roles for design that co-exist on the boundaries of economic mainstream of design practice are also discussed as they offer direction on how design can prolong product lifespans. In particular, the emergence of eco-design and sustainable product design practices are investigated. Such evolving practices are important to this research as they offer a framework for design practice that can meaningfully engage with issues such as product obsolescence.

3.1_The Streamliners

Industrial design as a professional service to industry emerged in the United States in the 1930s. Following the stockmarket crash of 1929, the ensuing devastating economic depression intensified competition that led manufacturers to adopt increasingly sophisticated tactics to boost sales. Income from manufacturing had contracted by two-thirds between 1929 and 1932 (Meikle 2001). It is around this time that the first generation of consultant designers, including Raymond Loewy, Walter Dorwin Teague and Henry Dreyfuss established their design practices. Initially, they had little success, but soon rose in prominence and all went on to enjoy long, successful careers. The key to their success was through product styling, which was adopted by manufacturers as a means of making their products distinctive from their competitors. Along with advertising, celebratory product endorsements and the newly devised purchase-on-credit schemes, styling represented a key role in the arsenal of increasingly sophisticated marketing strategies adopted by manufacturers (Meikle 2001). One particular devised style

[6] Reference is made to both 'industrial design' and 'product design'. However, for the purposes of this research, the terms are used interchangeably. Industrial design is often considered a somewhat anachronistic and misleading term considering the expanding role of designers. However it is still widely used in the literature, and by industry and academia.

that captured designers and the public imagination was streamlining. This was influenced by the scientific discoveries and technological advances of the day, including understanding of aerodynamic forces from wind-tunnel testing and studies of tapered forms such as of dolphins. The emergence of metal-skinned aircraft and huge intercontinental airships captured designers' imagination and the public's heart. The innovative and enduring Douglas DC-3 [Refer to Figure 10] expressed the very essence of modernism in a new streamlined form of polished aluminium. Of the DC-3, Walter Dorwin Teague wrote:

> *The line begins along the backbone of the body, to rise slowly in a gentle curve, then suddenly sweeps upwards in a straight, steep leap to a startling height, arches backwards as if its energy were spent, and drops straight down to the axial line of the fuselage. There is surely no more exciting form in modern design* (Teague 1946: 143)

Figure 10: The streamlined all metal skin Douglas DC-3 [photo: Paul Haliday 2007]

Streamlining became the aesthetic of the machine age signalling efficiency, speed, hygiene, science and technological advancement of the new modernism. Even stationary objects, such as refrigerators, toasters, pencil sharpeners and vacuum cleaners, were designed in the streamlined style despite their dubious requirements for aerodynamic efficiency. The observation was made that streamlining was also a metaphor for business, as it reduced customer resistance, leading to increased sales. It was seen by its proponents as a metaphor for consumption, enabling the flow of a 'river of goods' by reducing the parasitic drag or its counterpart, overcoming the 'psychological drag' of consumers who refuse to give up the old for the new (Lough and Gainsborough cited in Meikle 2001: 72).

It wasn't co-incidental at this time that the proposition of product obsolescence found prominence among US marketeers (Slade 2006). In a book titled *Selling Mrs Consumer*, Christine Frederick argued the case for obsolescence in the home by suggesting a doctrine of 'creative waste', hailing "America's triumphs and rapidity of progress are based on progressive obsolescence[7]" (Frederick cited in Adamson 2003: 4). Streamlining would play a vital role in signalling technological and psychological obsolescence of old and dated products. A newspaper advertisement for the Raymond Loewy-designed streamlined Sears Roebuck 1935 Coldspot Super Six refrigerator[8] [Refer to Figure 11] captures this link between design styling and creating desire for new technologically advanced products:

> *Stunning in its streamlined beauty! This luxurious and convenient refrigerator . . . new in design – modern – streamlined, arrestingly beautiful* (Arens cited in Meikle 2001: 4).

Figure 11: The 1935 Sears Roebuck Coldspot super-six refrigerator (Sears 2008)

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[7] "Progressive obsolescence", is a term attributed to Justus George who advocated in 1928 that Americans be taught to trade in or discard old items for new, more attractive ones (Rutherford 2003).

[8] It is claimed that the Loewy-designed streamlined fridge increased sales "from 15,000 to 275,000 [units] in five years" (Smith 1993: 373-374).

Parallel to the efforts of the manufacturing industry to entice consumers to start buying again, the US government was instrumental in stimulating the post-depression economy. The rollout of infrastructure, roads, dams, bridges and electrification networks, especially into rural regions, under Roosevelt's New Deal reforms enabled for many access to the electricity grid and paved roads to their homes. This newly available infrastructure opened the way for ownership of the newly designed streamlined products for the home. Refrigerators, cars, electric cookers as well as the design of capital equipment, trains, buses and telecommunications equipment all helped fuel the economic recovery (Votolato 1998), thereby creating new opportunities for designers.

3.2_Profit with principles?

Industrial design in the new post-war Europe firmly established itself as a subset of industry – subservient to the role of management and marketing – to be deployed as a strategic tool to increase sales (Margolin 1998). While this role for design has remained dominant, other models of marginalised design practice and dissenting voices promoting alternative models of design have remained. These include advocates for design as a service to human and ecological values ahead of short-term economic prerequisites as required by the competitive manufacturing industries.

A notable early example is the early work of the German architect Peter Behrens for electrical company AEG. In 1907, Behrens established a corporate scheme for AEG that included co-ordinating the design of a range of electrical products thereby, establishing new styles for the new century (Sparke 1986). However, with political and social instability in Germany leading to war, the emergence of the consultant designer was delayed until the end of hostilities in 1946. Post-war, the emphasis was initially on the design and production of utilitarian and functional products to meet the urgent needs of the population. Shortages of raw materials and limited manufacturing capacity ensured that frivolous activities such as styling were put on hold for the time being. With food rationing in the UK lasting well into the 1950s, the wartime sentiments of make-do-and-mend (HM Government 1943) lingered on in the public's mind. Economic recovery and consumer spending was far from swift as industry initially struggled to meet pent-up demand for modern consumer goods (Heskett cited in Adamson 2003).

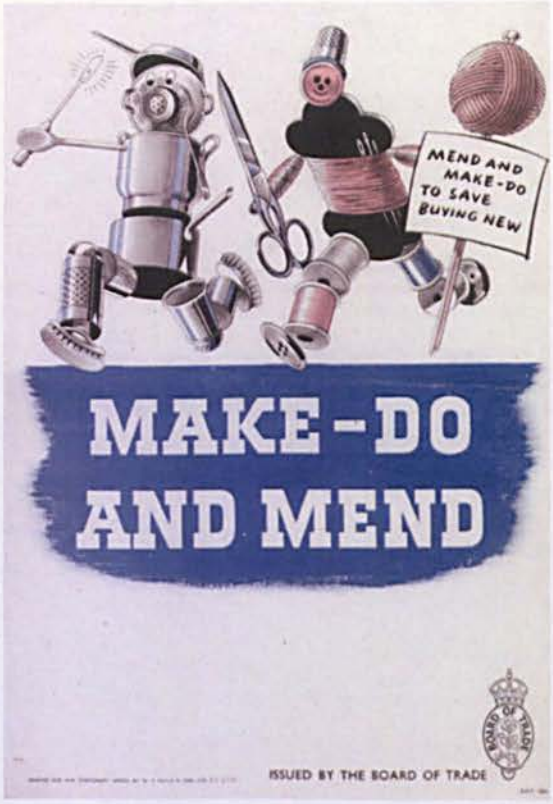

Figure 12 Make-do and Mend pamphlet (H.M. Government 1943)

UK Government sponsorship for design was initiated to promote and co-ordinate efforts to rebuild British industry and consumerism. The formation of the UK Council of Industrial Design and the 1946 Britain Can Make It exhibition, both backed by government, helped establish a role for industrial design aligned with the commercial interests of industry. The exhibitions confirmed in consumers' minds a desire for new products. A statement from the 1946 Mass-Observation Report[9] on the Britain Can Make It exhibition sums up the importance of such projects in sowing the seeds for post-war consumerism:

> *...it is not so much that old tastes have been changed but that new ideas have been planted. Thus, the builder's wife says: "It has given us a lot of new ideas on things we want", and a nurse remarks: "what I want now is different from what I wanted when I came into the Exhibition because there are things that I have never seen before".* (MO report on BCMI, cited in Darling 2002)

[9] Mass observation is a social research project that commenced in Britain in 1937 and continues today. Initially, recruited volunteers responded to questionnaires on a variety of matters of the day. The aim of the project was to create an "anthropology of ourselves" a study of the everyday lives of ordinary people in Britain (Mass Observation 2009)

However, it was the US consultant industrial designer model of practice in rebuilding national economies and increasingly become embedded within competitive global manufacturing activities that have defined post-war consumption (Margolin 1998). Misha Black, a British designer of the period, sums up the tension between European and US distinctions on the role of design:

> *"Since the 1930s the industrial designers and their well-wishers and critics have balanced uneasily between a conviction that their duty is to support the tenets of William Morris and combine beauty with utility, and pressures to follow the credo of Raymond Loewy and see beauty only in the upward sweep of the line on a sales graph".* (Black 1983: 179).

The principles of earlier and alternative influential design philosophies espoused by the Arts and Crafts in the UK and the Bauhaus in Germany (to name just two) of attempting to understand and meeting peoples 'real' needs have remained for the most part outside or have been appropriated in a diluted commercialised form by the competitive marketplace. Industrial design in the new post-war Europe firmly established itself as a subset of industry – subservient to the role of management and marketing, to be deployed as a strategic tool to lift sales (Margolin 1998). Despite the marginalised position of other models of design practice and dissenting voices promoting alternative models of design have remained. These include advocates for design as a service to human and ecological values ahead of short-term economic prerequisites as required by the competitive manufacturing industries.

3.3_The crown prince of obsolescence

With the post-war economic recovery, and the dramatic rise in consumerism and manufacturing industries, obsolescence reappears in the literature. This time around, as it remains today, it becomes a much more contentious issue. In a brochure published in 1953, an American industrial designer of some prominence, Brooks Stevens, proclaimed that:

> *"The great strides of industrial design are yet to come through Planned Obsolescence".* (Stevens cited in Heskett 2003: 4).

Within a few years he had perfected his definition of 'planned obsolescence' which he was known to present at every opportunity. At one documented gathering of advertising executives, he said that by deliberately building in (planning) product obsolescence, "a struggling economy could be reinvigorated by creating fresh demand for new products" (Adamson 2003: 129). He remarked repeatedly "instil in

the buyer the desire to own something a little newer, a little better, a little sooner than is necessary" (Stevens cited in Heskett 2003: 4). It was a message not always gratefully received by detractors. To the general public, planned obsolescence first came to notoriety through the highly popular writings of Vance Packard who slammed Stevens in his best-selling book *The Waste Makers* (Packard 1963) as 'the crown prince of obsolescence' (Packard cited in Heskett 2003: 5). [Refer to Section 2.5 for a further explanation of Packard's analysis of planned obsolescence]

Even within the US design fraternity the idea of planned obsolescence was controversial. Walter Dorwin Teague, a founding figure of industrial design, wrote that:

> *"This practice of making previous models look outmoded when new models have no better service is known as 'planned obsolescence' or 'artificial obsolescence' – the latter being the more accurate term but still not as accurate as just plain gypping".*
>
> *Teague further asserted that most firms were engaged in* "honest legitimate obsolescence in making products more serviceable, less costly" *(Teague cited in Heskett 2003: 6-7).*

He suggests that where there is clearly a functional and cost advantage for the customer (rather than just for the profit of the manufacturer), a degree of obsolescence is legitimised. A similar argument for legitimising obsolescence is made today through promoting the replacement of older, less energy-efficient products with more efficient ones (Chalkley et al. 2003).

3.4_Evolving new roles for design

Ironically, it was Richard Buckminster Fuller[10], a pioneer of US corporate design and an early adopter of streamlining, who helped launch the World Design Science Decade in the 1960s. A 10-year program began in 1965 to devise ways in which design could address major world problems (Margolin 1998). His work and extensive writings on the future survival of humanity has been interpreted, more recently as a philosophy of sustainable design (Fuad-Luke 2004).

From a different perspective, the actions of workers at Lucas Aerospace to save thousands of jobs offers a more applied example of changing the way design is

[10] Buckminster Fuller is probably best known for his earlier architectural work experimenting with lightweight geodesic domes and prefabricated housing.

deployed. In 1976, the Lucas Plan (as it came to be known) harnessed the design and engineering expertise within the company to redirect activities from the design of weapon systems to the design of socially useful products – including medical equipment, and alternative energy and transport systems[11].

Perhaps the best-known person advocating an alternative role for design is Victor Papanek. In the 1970s and early 1980s, Victor Papanek was the leading voice of design dissent. Through lectures, writing and student projects, he articulated an alternative path for designers, encouraging them to engage with environmental, social and ethical effects of their work. He was an outspoken critic of the design industry that perpetuated planned obsolescence. In the preface to *Design for the Real World*, Papanek wrote:

> *"there are few professions more harmful than industrial design, but only a very few of them"* (Papanek 1984).

He argued that designers were pre-occupied with fashions and fads, focusing far too much on aesthetics and styling. However, he was not without detractors, who accused him of simplifying "consumers as ignorant, duped and dumb", and "management as simply greedy and designers as serfs" (Morgan 2000: 91). Irrespective of the simplicity of some of his arguments and the crudeness of the many projects he supervised, *Design for the Real World* was translated into 21 languages and remains one of the most widely read books on design (Fuad-Luke 2004).

Since then, many other books have followed with a succession of similar ideals exploring new roles and the responsibilities of designers by arguing for a rebalancing of social and environmental needs against the economic imperative that drives the design industry. For instance, Nigel Whiteley's book *Design for Society* (1993) considered some of Papanek's earlier themes of ethical design by focusing on the social roles for design, while Dorothy Mackenzie's book *Green Design: Design for the environment* (1991), reported design initiatives to tackle the environmental impacts of products.

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[11] One product developed under the Lucas Plan was a hybrid petrol/ electrical car that had half the fuel consumption and 80 per cent less exhaust emissions than comparable cars of the time. However, the limitations of battery technology (of the time) ensured the vehicle was not commercially viable (Fry 2009).

3.4.1_ Designing for the environment

It was at a similar time, in the early 1990s, that a loose set of compatible principles began to emerge under the banners of eco-design (Tischner et al. 2000) and design for environment (DfE) (Lewis and Gertsakis 2001) and green design (Mackenzie 1991). These terms refer to strategies that aim to integrate environmental considerations into product design and development (Tischner et al. 2000). Strategies may be applied singularly or in combination depending on the priorities and capabilities of the design team and the nature of the project undertaken. [Refer to Figure 13]

- Low impact materials
- Avoid hazardous materials
- Cleaner production processes
- Minimise choice and quantity of materials
- Efficient distribution
- Energy (and water) efficiency
- Optimised Long lifespan
- Design for disassembly
- Waste minimisation

Figure 13: Eco-design strategies (Modified list from Lewis & Gersakis 2001; White et al. 2004; Design Edge 1994 – Appendix 3)

A particular strategy featured on this list is the inclusion of prolonging or optimising product lifespans. However, prolonging product lifespans – while stated as a desirable eco-design outcome – can conflict with other eco-design strategies, especially efficiency. Is it more desirable to replace an old inefficient product with newer more efficient model? The predominant point of view would suggest that efficiency should take precedence over increased longevity, especially when considering EuPs (Chalkely 2003; van Nes 2003).

Life cycle assessment (LCA) studies would concur. For example, one LCA study for a washing machine found that up to 90 per cent of impacts could be attributed to the 'use' phase of the product (Simon et al. cited in Cooper 2005). Depending on the weighting of priorities and assumptions made, projected product lifespans and frequency of use (within a LCA study), a recommendation to prolong a product's lifespan would be unlikely outcome. LCA studies, almost always, also consider product lifespans to be constant over time (Babbitt et al. 2009). Considering the lack of empirical studies on actual product lifespans for specific product categories, this situation is understandable. However, the weight of evidence from the many other indicators, including product sales figures and e-waste volumes, suggests that product lifespans are shortening in many product sectors. To base planning

decisions on LCA studies which are themselves based on inaccurate lifespan assumptions will result in misleading product-planning decisions.

3.4.2_ Eco-efficiency and product lifespans

Efficiency remains a primary objective of government agencies, manufacturers and environmental advocacy groups in reducing environmental impacts of products. To illustrate, take the case of the highly visible and publicised energy-labelling scheme[12] administered by DEFRA for household appliances. [Refer to Figure 14] At the same time, eco-design practices have co-evolved around this efficiency agenda, often defined in terms of technological parameters such as reducing energy demand (by the product), use of lightweight and minimal use of materials.

Despite its wide acceptance as a way of tackling environmental problems and resource depletion, eco-efficiency has its detractors as a way of delivering environmental gains. [Refer also to Section 2.6.3]

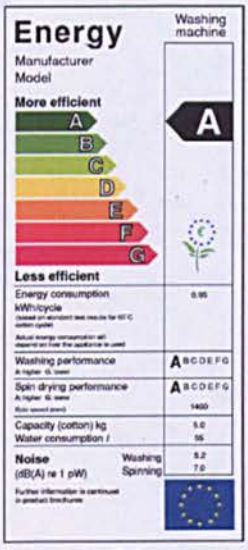

Figure 14: EC energy label (Defra 2005b)

The principle of 'factor four', popularised through the book *Factor Four: Doubling Wealth, Halving Resource Use* (Von Weizsäcker et al. 1997) argues that for sustainability to be met, resource productivity should be quadrupled. This is to be achieved to enable a doubling of wealth at a global level, while halving resource

[12] There are calls for the scheme to include information about the predicted lifespan of a product to enable price (or efficiency) per year to be calculated (Cooper cited in House of Lords 2008).

use. Von Weizsäcker argues "durability is one of the most obvious strategies for reducing waste and increasing material productivity" (1997: 70).

From the momentum that gathered following the publication of the Brundtland Report *Our Common Future* (1987) – that first defined the principles of sustainable development – eco-design practices realigned with this emerging understanding as sustainable product design (SPD). SPD offers a means of recognising social and ethical impacts of product design (Fuad-Luke 2004; Tischner 2001). As with eco-design, trade-offs often have to be reconciled. For instance, where environmental aspects are improved, it may be at the expense of a social improvement or visa-versa. One way for designers to understand and try to reconcile social and environmental impacts is to investigate the entire lifecycle of a product – starting with the supply chain and finishing with a product's end-of-life. Depending on the adopted method or analytical tool used to investigate the lifecycle a designer is able to identify impact 'hot spots' in order of priority.

In more recent times, sustainable consumption and production (SCP) has emerged on the policy agenda as a way of framing responses to the complexities of sustainability. This represents a shift from earlier government and industry actions that have either focused upon 'end-of-pipe' waste treatment or cleaner production initiatives. SCP shifts the focus actions to the middle, where demand for resources and wastes is generated. It is also in the consumption phase (the acquisition, use and disposal of products) that product obsolescence occurs. As a consequence the emergence of SCP agendas has contributed to a renewed interest in product lifespans (Cooper 2008). It also places new demands on design to find ways in which products and services can be devised to meet sustainable consumption agendas (DEFRA 2005; Richardson et. al. 2005).

As a spinoff from the slow food movement – that first emerged in Italy in 1989 as a reaction to the spread of fast food and disappearance of local food traditions (Slow Food 2008) – the proposition that design could also be slow was explored. Slow design (Fuad-Luke 2006) shares some overlap with designing for product lifespans. The ethos of slow design fits with prolonging product lifespans as the objective is to offer a counterbalance to the 'speed' of industrial and consumer culture.

Some products are inherently fast while others are slow. A paper coffee cup is fast while a ceramic mug is slow. For the designer, 'slow' presents the challenge to 'finesse' and resist the force of speed by being sensitive, skilful and strategic in undertaking design projects (Thorpe 2007). Another aspect found in the guiding principles of slow design is the principle of co-production or an open-source ethos.

'Slow folk' consider themselves co-producers and partners in the production process, not as passive consumers (Slow Food 2008).

3.4.3_Designing for product life

Designers have an instinctive empathy for long product lifespans. However, a tension often exists between the interests of the designer and those of the manufacturer. The former often seeks to create an enduring and meaningful design solution, while the latter is often more motivated by revenue growth driven by annual sales turnover. The status of certain designers whose designs have achieved the enduring status of a 'design classic' and the number of prestigious design awards attest to this assertion. Despite the promise of repeat business, few designers would like to see the results of their design effort superseded by another new product soon after a market launch.

Most of the literature on the role of design strategies to prolong or optimise product life is relatively recent (Heiskanen 1996; Cooper and Mayers 2000; Burns 2003; Chalkey et al. 2003; van Nes 2003). Heiskanen (1996) describes a range of product design strategies to prolong product lifespans, [Refer to Figure 15]

- the use of durable materials and construction
- modularity in design
- interchangeability of parts
- multifunctionality
- repairability
- ease-of use
- availability of user manual and instructions
- aesthetic characteristics
- operating and maintenance costs
- automatic fault detection
- built in safety features

Figure 15: Design strategies to prolong product lifespans

Many of these strategies are not necessarily new. Some – including modularity, repairability and durable construction – are also found in the eco-design or design for the environment (DfE) literature (Lewis & Gertsakis 2001; Tischner 2001; Mackenzie 1991).

The Dutch book *Eternally Yours: Visions on Product Endurance* (Van Hinte, 1997) tried to address the lifespan of products through a collection of essays on design theory, design research and examples illustrating how product obsolescence could be challenged. The book was the result of an event held in April of the same year

as publication. The Eternally Yours Congress set out to discuss the three main aspects of product life extension. [Refer to Figure 16]

- Shape 'n Surface - deals with actual products, the materiality, form and configuration of a product
- Sales 'n Services - considers the organization of a system around longer lasting products, such as, Product Service Systems (PSS)
- Signs 'n Scripts investigates product meaning, including the control of stories around products

Figure 16: Thematic structure of the Eternally Yours Congress (van Hinte, 1997: 20)

The Eternally Yours text introduced many designers to new concepts concerning perceptions of product quality, storytelling, ageing, wear and product service systems. For example, it discusses the desirable aesthetic qualities of ageing (wear) of leather and wood as found in antique furniture or a well-used tool or well-loved item of clothing. The book attempts to negotiate the theoretical, practical and creative interface between the product (design) and the consumer (psychological and socio-cultural influences).

Product life and design has been the topic of PhD research. Two notable contributions have been by Nicole van Nes and Ann Marie Chalkley. For instance, van Nes (2003) offers design examples, both conceptual and real, of products with extended lifespans. She highlights that replacement decisions can be influenced through product design. She proposes that if a product is dynamic and flexible in design, it has a better chance of resisting the complex dynamics of motivations to replace it with a newer product. The three approaches she discusses are:

Modularisation is a strategy where subassembles, when they become technologically obsolete, can be updated easily by the user. Van Nes discusses the concept of fast and slow technology (Thorpe 2007). Modular design strategies offer a way to even out discordances between fast and slow technology. For instance, a hard disk in a computer is fast technology, where technical innovation is rapid A power supply in a computer is a slow, technical innovation where upgrade is of little consumer benefit.

Emotional attachment to a product can be triggered in many ways (Chapman 2005, Mugge et al. 2005). Van Nes suggests that products incorporating some playful interaction can engender an emotional attachment. Playful interactions, such as a mileage recorder in an iron – how ironing miles have been achieved – build a relationship between user and the product. The product becomes personalised and is a carrier of memories.

Fashion upgradeability through replacement parts such as fascia panels and covers. The appearance of a product can be updated to contend with issues such as fashion obsolescence as well as offering a personalised look.

3.4.4_Recasting Industrial design

Many leading design thinkers have made a call to recast new roles for design (Walker 2006, Margolin 1998; Thackera 2005; Sterling 2005, Ingram et al. 2007). Other design roles do exist but remain mostly outside the mainstream and are often deemed as incompatible (Walker 2006). Local-scale initiatives, long product lifespans, attention to specific user needs – all of which are encompassed by various sustainable design practices – often struggle to find a fit with conventional design practice. Despite some notable exceptions where such initiatives (for example, durability) are explicit[13], embracing such principles would require radical change to business practices that are often beyond the remit of the designer. Professional design services have been mostly framed as a subset of business practices, in particular marketing. As a consequence, material culture in mainstream design practice is often defined in narrow economic terms – designing products (commodities) that enable customers' needs to be met while optimising a profit for the designer, producer and supplier.

Stuart Walker's critique offers a useful comparison between conventional and sustainable design practices. He suggests that to create more meaningful objects in our material culture, it will require engaging with the consumer in new and more meaningful ways. One proposal is to involve the user in the co-production of a product. This shifts a role from the design professional to the amateur designer. This clearly has implications for prolonging product lifespans and is discussed in more detail latter in this report [Refer to Chapter 9] by involving the user as a co-producer in reshaping a product to meet changing circumstances.

[13] For example, durability is a feature of products and appliances marketed by Dualit, Miele, Volkswagen and Bosch.

Conventional design	Sustainable design
Industrial design	Design of functional objects
Product design	Creation of material culture
Specialisation	Improvisation
Professional	Amateur, dilettante
Instrumental	Intrinsic
Problem solving	Experimenting
Solutions	Possibilities
A prior design	Contingent design

Figure 17: Reframing design qualities (Walker 2006: 38)

Others have echoed this call for a discursive design involvement of the user in the co-production of products. 'User-oriented design practices' (Ingram et al. 2007), self-centred design, design amateurism and adaptive design (Hill 2004), are some of the many terms used to describe this activity. By shifting from a product-centred to a user-oriented design practice, products can be shaped to fit a specific context determined by the user. Products exist in a world of changing meaning, during a process of acquisition, consumption and use. Products that are adaptive (in design) may be more resilient to obsolescence. Shove, Watson, Hand and Ingram (2007) discuss this idea of a 'two-way traffic' between designer and the user in the co-production of things. Embracing this idea, a new role emerges for the professional designer as a designer of 'open products' (Hill 2004). By leaving products open, the designer creates a context for user-oriented design that enables users to reconfigure, reform, adjust and evolve a design to meet wishes, needs and aspirations of those users. A new relationship is explored and defined between the producer and user. The amateur designer as a hobbyist, tinkerer and product hacker (Make 2005) is a manifestation of a user-centred design approach. These post-acquisition design practices are often unexpected by the original design team and manufacturer, but are surprisingly common. The next chapter explores examples of these practices. [Refer to Chapter 4]

4_Prolonging product lifespans

This chapter reviews and classifies examples of prolonged lifespans in relation to consumer electronics. By identifying product attributes, user behaviours and societal influences that exhibit characteristics of prolonged product life-spans, strategies can be identified and developed to be applied to design projects.

In the face of the many forces driving obsolescence, examples exist of products, behaviour and societal influences that can prolong product lifespans. More than half these examples are informal in that they have evolved because of particular situations or individual users' circumstances. Some examples exhibit elements of a planned design or a business strategy. However, they aren't common. One area that articulates a planned response to prolonged product lifespan is found in the eco-design literature. Eco-design strategies often mention extending product lifespans (Lewis and Gertsakis 2001; Tischner 2001). For examples, a typical eco-design approach to prolonging product lifespans is to design modular or upgradeable products. [Refer to Section 3.4 for a more detailed description of these and similar strategies.]

A recurrence emerging from this chapter is the prevalence of unplanned factors that can significantly influence the prolonging of product lifespans. These unplanned interventions made during the consumption phase of a product's life, or at the point when it is no longer wanted, offer the foundations that enable new formalised approaches that can be embedded within the design process to be developed.

4.1_Examples categorisation

Examples presented in this section have been collected from published literature, websites, exhibitions and the author's collections. To enable clarity in presentation and assist in the analysis of such diversity, they are grouped into three categories:

1. Product (features)
2. Individual user (behaviour)
3. Societal (socio/economic)

These examples are intended to be illustrative and are by no means comprehensive. The relationships between the categories are arranged from the micro (at the individual product level) to the macro (at the societal level). [Refer to Figure 18]

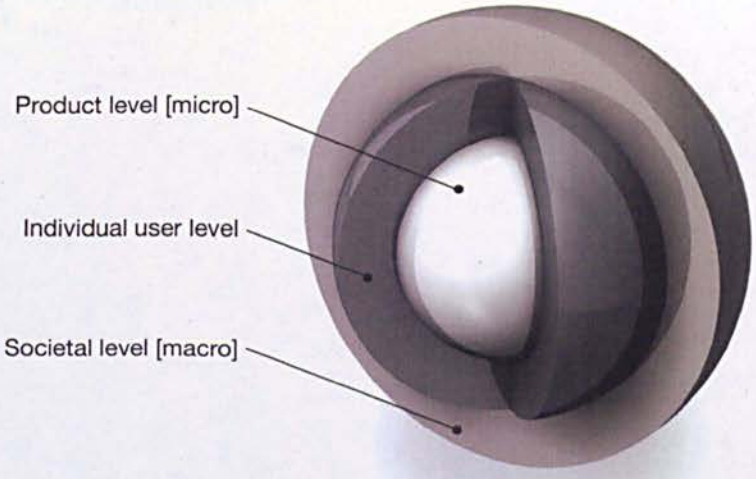

Figure 18: Micro to macro, from product to societal factors

'Micro' refers to those features predominantly specific to the product. These features concern the materiality of a product, including materials, surface treatments and finishes, form, and component configurations. The middle ring represents individual user behaviours that can influence product lifespans. At the other end of the scale, 'macro' refers to the wider socio/economic contexts, including secondary markets, information networks and business models. These are societal factors that are typically collective, networked or organisational, involving social, cultural and economic practices. Specific examples discussed within each category are summarised in the table below. [Refer to Figure 19]

	Unplanned	**Planned**
Product level	Ageing gracefully Silent performers System interdependence	Upgrading Piggybacking Luxury products Scripting
Individual user level	Repurposing Embalmers Tinkerers	Collectors
Societal level	Fashion cycles Design classics	Auctions, Markets, Second-hand traders Product Service Systems Information networks

Figure 19: Category groupings of examples of prolonged life-span

4.2_Product-level attributes

Product-level attributes are concerned with features found within the actual product. They include materials, surface treatments, finishes, construction, subassemblies, components and product structure. Particular attributes that can lead to a prolonged product lifespan are described in further detail below. They include: ageing gracefully, upgrading strategies, Scripting, Piggybacking, silent performers, system interdependence, Reassignment and luxury products.

4.2.1_Ageing gracefully

Materials are of great importance when assessing a product's durability and ongoing desirability. Plastics are one class of materials closely associated with consumer electronics and industrial design. They offer a range of qualities and performances unrivalled by any other class of materials. However, they have a number of persistent shortcomings, including the persistent perception that they are often an inferior substitute for other more 'quality' materials (Lefteri 2008). Early attempts and motivations behind the production of products in plastic polymers have been described as a process of "substitution, imitation, and innovation" (Meikle 1995: 11). Plastics' bad reputation can also be attributed to design. When first introduced, the new material was poorly understood, resulting in the inferior design of flawed plastic products (Meikle 1995). Even today, plastics are often associated with 'cheap', 'shiny products' and 'disposable packaging' (Lefteri 2008).

Its reputation is also condemned by the many environmental impacts associated with its use. When discarded, the slow degradation of plastic products can lead to many detrimental impacts. However, plastic degradation often starts before it is discarded. The ageing of plastics results in aesthetic and functional performance degradation. This can take the form of loss of clarity, crazing, cracking, warping, dusting, or colour bleaching. For example, when used for facia panels and external housings, aesthetic degradation is likely to result when the material is exposed to ultra violet (UV) radiation (sunlight) for sustained periods.

Aesthetic degradation of a product can also be accelerated by poor design or disregard during frequent use. Spray painted, polished or smooth-surface finishes are common on many portable consumer electronic products such as laptops, mobile phones and digital cameras. Polymers such as ABS can be finished using a plating or vapour metal deposition process that allows for mirror finishing that offers a chrome or metallic appearance. The problem with these and similar finishes is that despite improved surface hardness, polished surfaces are prone to surface

scratching, a highly visible form of aesthetic degradation. [Refer to Figure 20] The Apple iPod, with its mirror-finished surfaces and crisp edges is an example of how product wear can be accelerated – hence the popularity of 'skins' or covers to protect such devices. In such cases, the designer plays an influential role in determining the rate of aesthetic degradation through decisions made about materials, surface texture, finish and product form. The use of generous edge radii, uniform polymer pigmentation (rather than surface finishes) and textured (rather than smooth) surfaces are just three simple practical measures that can slow aesthetic deterioration of a product.

Figure 20: Apple iPods, the new and the not so old [photo: author]

In some circumstances, marks and scratches a product acquires in its lifetime can become a desirable feature. The aesthetic ageing of products was a theme explored at the *Eternally Yours Congress* in 1997 (van Hinte 1997). The event explored perceptions of product quality, ageing and wear, citing positive examples of aesthetically acceptable wear. The patina of wear can be a record documenting a product's lifespan (McCoy 1997). Hence the appeal of items such as antique furniture, a well-worn leather belt or wooden handtool. However, we are less tolerant of patina on electronic products. Perhaps for good reason, as such markings often indicate misuse or misadventure. Despite this misgiving, not all electronic products need to be condemned in this way.

Wear on so-called semi-professional equipment can be advantageous by linking aspirations of the amateur consumer to professional usage of the product. The

logic of these 'positionally' marketed goods presupposes that professional equipment is manufactured to a higher specification than an ordinary consumer marketed product to take the knocks and abuse of daily professional work. Ribs, bumps, dimples and textured surfaces are stylistic devices the designer can deploy to enhance the perceived qualities of professional ruggedness. They are commonly found on consumer goods such as camping and gardening equipment, and power tools. Nicks and scratches on these products are often acceptable to the user and can in some cases enhance the rugged appearance of the product. For example, through materials selection, surface texture and detail, the Bosch GSR cordless drill range communicates a message about toughness to its owners and their 'professional' DIY aspirations. Ribs, dimples and generous radii on corners enhance the perception of robustness. Bosch further reinforces the distinction between professional and consumer markets by colour-coding their product range – green for domestic consumers and blue/green (teal) for professional consumers (Bosch 2009). The distinction is further reflected in their price points. [Refer to Figure 21]

Figure 21: Nicks and scratches are aesthetically acceptable on rugged tools such as power drills [photo: author]

4.2.2_Upgrading

If a product is designed to be flexible in its configuration (i.e. upgradable), it has a better chance of resisting the complex dynamics and motivations to replace it with a newer product (van Nes 2003). Upgradeability often involves the replacement of certain parts, either hardware or software, to keep up with the latest technology or

enhance functionality. In some instances, it may be mandatory to correct a flaw or shortcoming within the product. This is especially the case when product safety is involved. The upgrading of computer software is probably the most familiar and widely ritualised practice of upgrading. The upgrading of computer hardware may also be an equally valid approach, but is often fraught with difficulties for the inexperienced. One formalised way this could be overcome is through the modularisation of subassemblies within a product. An example of this proposal is illustrated below within a project undertaken by a student supervised by the author. [Refer to Figure 22] Each of the technologically critical components – including memory, hard drives, graphics cards and CPU – can be upgraded through a simple plugin modular arrangement of subassemblies.

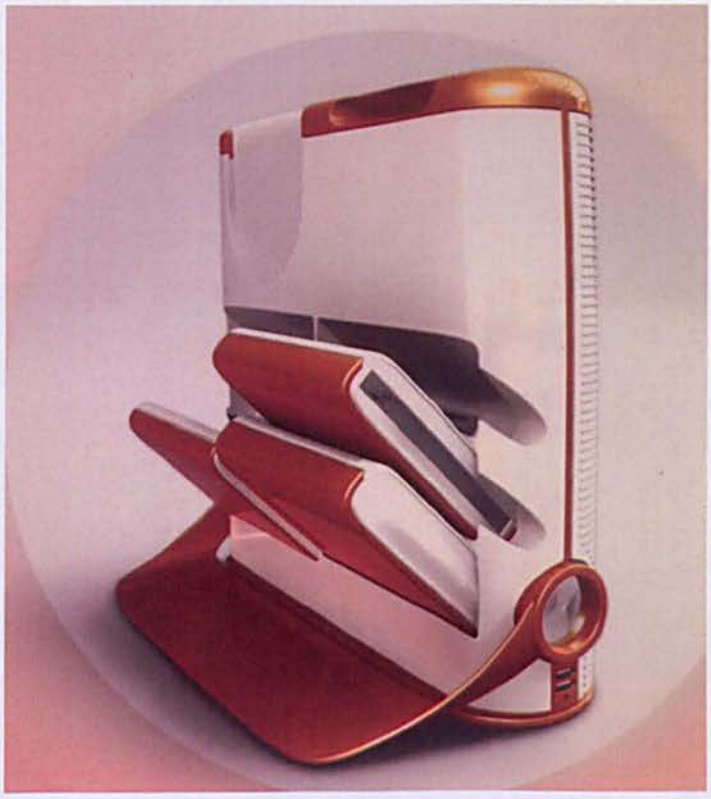

Figure 22: Student design for a modular computer [UCA student: Robert Mansfield]

This example illustrates how design can even out the 'fast and slow' (Thorpe 2007) technologies found in many consumer electronic products. van Nes (2003) also describes how technological ageing is uneven. Computer memory is an example of fast technology where technological innovation is rapid, whereas a power supply is much less subject to technological change. Thus, an upgrade to the power supply may be of little perceived benefit, while a memory upgrade may offer significantly improved performance. She proposes the adoption of a modular upgrade strategy

as a way of evening out the discordances between fast and slow technology within a product.

Aesthetic upgradeability can also provide a way of slowing obsolescence that arises from changing fashions. A product's surface or 'skin' may be replaced to change and personalise its look or to replace worn surfaces. The system of replaceable covers was a common feature with mobile phones in the 1990s. More recently, this concept has been exploited through the offering of replaceable skins for Apple iPods to protect and personalise the product.

4.2.3_Scripting

> *Artifacts can evoke specific treatments, by their very functioning and by the use they imply.* (Verbeek & Kockelkoren 1997: 109)

For the designer, a practical eco-design approach to improve product lifespans is to design products that can be upgraded (Lewis and Gertsakis 2001). However, for consumers, deciding on when and how to upgrade a product is a less clear proposition. One approach that may address this problem is Scripting, a process that weaves product design with user psychology. In a film or play, the role of the script is central to defining actors' dialogue and actions. Similarly, it can be conceived that a designer may devise a script for a product to define a role the user can play (Ingram 2007). In this context a script is a means by which a technology 'configures its user' (Woolgar cited in Ingram, 2007). Other authors discuss guiding behaviour in terms of perceived affordances (Norman 2000), persuasive technology (described as Captology) (Fogg 2003), design with intent (Lockton et al. 2008), design behaviour[14] and sustainable use (Bhamra et al. 2008). These interrelated fields of study share much in common with Scripting as they are concerned with understanding and guiding behavioural change through the agency of design.

Scripting is about the relationship between things and people, a role not unlike that defined by ergonomics. In spite of this similarity Scripting does not feature in the ergonomics literature. This may be because ergonomics is concerned with operational aspects of actual product use, the 'world of work' (Pheasant 1998), whilst Scripting guides behaviours and routines around a product.

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[14] The terminology design behaviour was devised in collaboration with the author for the Design I Behaviour seminar held in London in April, 2006. [Refer also to Chapter 6]

Scripting attempts to modify or guide user behaviour through product design such that the user behaves in a prescribed or 'scripted' manner (Jelsma and Knot 2002). Bruno Latour offers a dated but often-cited example of this proposition. Older-style hotel key fobs were often designed to be large and heavy to encourage their return to the reception desk. Behaviour is said to be 'inscribed' into the key fob, guiding user behaviour to act as scripted (Latour 1992). Scripting to guide user behaviour is of growing interest to design for sustainability, particularly with regard to energy consumption (Backlund et al. 2007; Bhamra et al. 2008).

Similarly, product lifespan can be scripted. A coffee cup can illustrate this. A ceramic mug is inscribed with a script of reuse, while a foam or paper cup is inscribed with an opposing script of dispose-of-after-use. The materials used within the coffee cup are inscribed with a value that is expressed as a narrative of how we organise such products around our daily lives (Verbeek and Kockelkoren 1997). Other products may contain scripts to guide other types of behaviour such as enabling a user to maintain or repair a product. For example, leather shoes contain a maintenance script requiring the periodic application of shoe polish to restore the finish. Although shoes are rarely offered with detailed written maintenance instructions, maintenance behaviour is culturally inscribed within the materials of the product.

Scripts maybe opened or closed (Jelsma and Knot 2002). An open script is where the designer delegates a non-prescriptive or open-ended role for the user. This may include delegating a role to complete, evolve or reformat a product that could lead to various outcomes. For instance, LEGO blocks offer an open script by allowing a child to construct any number of possible designs. On the other hand, IKEA flat-pack furniture, another Scandinavian example, prescribes to the user a set of closed-scripted actions. The user is guided to complete the product through a predetermined sequence using uniform fasteners and prefinished self-jigging components, supported by pictogram assembly instructions. As with the hotel key fob example, a closed script sets out a prescriptive course of action the user has to comply with.

Using these simple examples demonstrates how Scripting might be applied to guide user behaviour in prolonging product lifespans. To be successful, a script needs to align with user logic (Jelsma and Knot 2002) by making use of cognitive biases and psychological heuristics (Fogg cited in Lockton et al. 2008) that are logical, learnable, economical and desirable. For example, prompts to perform maintenance routines on computer equipment such as defragmenting – often

referred to as 'defragging' – a hard disc or initiating a self-cleaning routine on a printer could be viewed as scripted behaviours that align with user logic.

4.2.4_Piggybacking

Piggybacking is a term devised by the author as a means of describing the opportunity where functionality can be renewed and enhanced in a technologically obsolete product through the addition of a secondary device or component. Much like upgrading, Piggybacking is as attractive strategy for consumer electronic products that are prone to technological obsolescence. It offers a means to balance out fast and slow changing technology within a product (Thorpe, 2007; van Nes 2003). However, it differs from upgrading as it involves the addition of a supplementary component or device to be added to the original product. The piggybacked devise is fitted adjacent or upon the original product.

A piggybacked component or device can be produced by a third-party supplier and not necessarily by the original producer, as is the case with many product upgrade products. In many instances, the piggybacked component or device would not have been considered during the original design of the product. Piggybacking is particularly suitable in tackling technological obsolescence especially where there has been a step-change in tech nology – for instance, with the introduction of digital TV broadcasting technologies. Commonly referred to as set-top boxes, the widespread adoption of digital television receiver units offers a good example of Piggybacking. The set-top boxes offer a practical piggyback solution, reducing the need to immediately replace non-digital equipment. The functional lifespan of the existing equipment is extended into the digital age.

Photography is another area that has also recently experienced a revolutionary technology step change. The rapid switch from film to digital photography has radically changed the way it is done, the equipment used, the way images are processed, and the businesses that supply photographic equipment and services. As a result of the migration to digital technology, many SLR (single lens reflex) film cameras have become obsolete. Despite this radical change, renewed functionality for millions of dormant film cameras could be extended through a Piggybacking strategy. A digital film module could saddle an existing camera mechanism. [Refer to Figure 23] A US company claims to have developed such a product . . . although disappointingly, without yet making a market breakthrough. They claim further investment is required. (Siliconfilm 2006).

Figure 23: Piggybacking digital 'E-film' into a 35mm film camera (Siliconfilm 2005)

4.2.5_Silent performers

An old adage suggests that the only time you notice your shoes is when they pinch. So it is with the many electrical products that inhabit our homes. Many offer long and reliable service, only drawing attention to themselves when they fail. These 'silent performers' as termed by the author – including hot water heaters, extractor fans and smoke detectors - are often hidden or go unnoticed. They are mostly unencumbered by fashion or rapid technological change.

Typically, silent performers are the antithesis of 'display' or 'positional' goods (Hirsch, cited in Jackson and Michaelis 2003) commonly associated with products that signal social status such as cars, mobile phones, watches and jewellery. In many instances, silent performers are hard-wired or installed in such a way as to discourage easy replacement. The need and additional cost of specialist removal and installation often contributes to a reluctance to replace, unless absolutely necessary. In such cases, replacement of silent performers usually only arises when the product fails and is uneconomical to repair.

A variation of the silent performer is a product that is downgraded to a secondary or backup role. With the changeover to digital audio broadcasting (DAB), many older analogue radios will be relegated to secondary roles within the household, displaced to less prominent locations such as the bedroom, study or garage. Despite their replacement, they still maintain value to the user in their new but demoted role.

Figure 24: Silent performer, demoted but still valued within the household [photo: author]

4.2.6_System interdependence

When an electrical or electronic product is interdependent with another product, obsolescence may be delayed. Alternatively, the replacement of one product may trigger the obsolescence of another. System interdependence, a term devised by the author, is an issue many computer owners face when considering replacing equipment. Will new equipment be compatible with the old? With a number of interdependent computer peripherals often linked to specific software and hardware configurations, there may be reluctance to replace equipment. The devised term 'system interdependence' works on similar a logic of mutually assured destruction (MAD). Replacing one component device can cascade, rendering other interdependent equipment inoperable and thus obsolete. The result is often to make-do for longer with the existing equipment deferring repurchasing decisions until the entire (interdependent) system can be replaced.

A variation of this theme could be termed surrogate interdependence. For instance, the interdependence of media formats used with a specific type of machine. For example, a VCR (video cassette recorder) may continue to remain in service

despite its technological displacement by newer digital technologies as a way of playing a valued VCR tape collection. To discard the VCR would mean loss of use of that videotape collection.

4.2.7_Luxury products

Expensive and premium-positioned goods are often marketed and perceived by consumers as durable and long-term purchases. Often designed and manufactured for long life, such products can defy both the relative (psychological, economic and technological) and absolute (product malfunction) forms of obsolescence.

Unlike an expensive watch or car, domestic appliances including commercial-grade toasters and high-end vacuum cleaners, may not generate the same emotional attachment from their owners but they are quite likely to outlive their cheaper counterparts. The Dualit polished stainless steel toaster retails for about 20 times more than its cheapest rival, but with its build quality, reputation and availability of replacement parts, it has secured a strong reputation in the marketplace (Brown 2005). Offsetting the initial one-off high purchase price against service life, such products may indeed offer better economic value over the long-term than cheaper lower quality counterpart products (Kostecki 1998). The residual values of such products are also higher when traded on secondary markets. An internet search for second-hand Dualit toasters attests to this assertion.

4.3_Individual user examples

Evidence suggests there is significant inconsistency in consumer attitudes and behaviours in relation to product lifespans (Cooper 2004; Evans and Cooper 2003). Nonetheless, individual users can have a considerable influence on prolonging product lifespans. In some instances, consumer attitudes and behaviour provide a distinctly positive role in prolonging product lifespans. The individual user behaviours described below offer examples of people whose actions show a defiance of product obsolescence. They are the collectors, embalmers and tinkerers.

4.3.1_Repurposing

Repurposing is when a product is adapted for different purpose. For instance, obsolete compact discs (CDs) can be repurposed for all sorts of simple secondary uses, including drink coasters, garden bird scarers or wheels for model cars. The literature on repurposing is mostly associated with user-orientated customised interventions; informal 'making' activities of turning one product into another by reassigning its new purpose or purposes (Make 2009; i-hacked 2008; Instructables 2008). The journal *Make: Technology In Your Time* (2009) celebrates the virtues of repurposing. *Make*'s audience centres on a do-it-yourself (DIY) culture of individuals with basic practical skills and basic knowledge in electronics, materials and fabrication processes. It encourages people to 'hack' products, especially consumer electronics, to create new 'homebrew' functionality (*Make* 2009). Beyond the practical step-by-step how-to articles, the journal is underpinned by an open-source philosophy. The publisher, Tim O'Reilly, is an advocate for the open-source software and for Web 2.0[15]. Both share much in common with values inherent in Reassignment strategies where authorship is shared or delegated to the user to become a co-designer of new things.

Repurposing is also a particularly common activity in developing countries, where through economic necessity and material scarcity, obsolete products are often put to new uses. In Cuba, for instance, man products are reconfigured to perform entirely new tasks. Examples include a plastic oil container reassigned as an illuminated taxi sign and a desk fan [Refer to Figure 25] made from recombining telephone components (Pentagram 2003).

[15] Web 2.0, a term co-conceived by O'Reilly, describes an online environment where users can contribute and participate in creating the content of a website (Musser 2006)

Figure 25: Desk fan made by recombining telephone components – Cuba (Pentagram 2003)

Similarly, the Russian curator, Vladimir Arkhipov, (2006) has collected an extensive range of contemporary Russian folk art of improvised, repurposed household products. Some of his more intriguing examples include television aerials fabricated from kitchen forks [Refer to Figure 26] and flowerpot bases made from gramophone records.

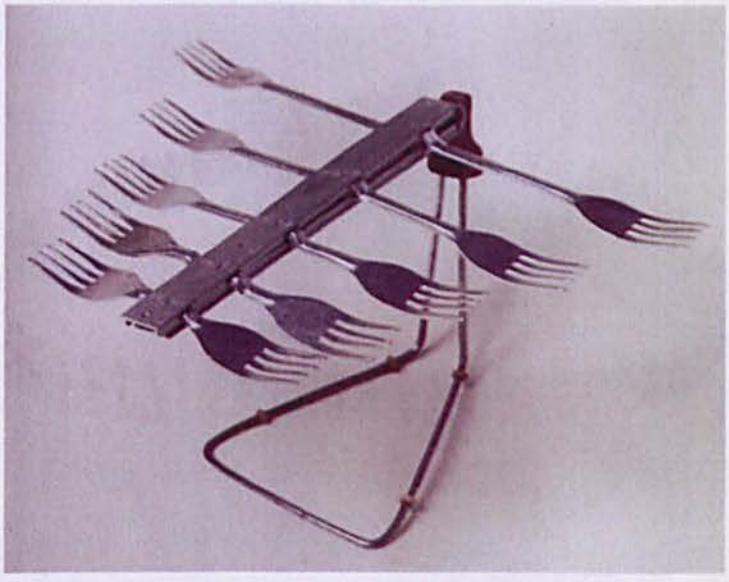

Figure 26: Russian fork TV aerial (Arkhipov 2006)

The Japanese phenomenon of Chindōgu, a word coined for the 'art of (un)useless ideas' offers an alternative more light-hearted approach to product Reassignment. It achieves this through the appropriation of everyday products that are applied to new and often bizarre purposes. (Ichiki and Umehara 2005; Kawakami 2004). Meanwhile, in our own culture, a form of repurposing has become the subject of books that illustrate how to recycle and make new objects for the home and garden out of obsolete products and packaging (Molesworth and Leighton 2006; Mackenzie 2000; Correll and Polk 1999).

4.3.2_Collectors

Collecting is a behaviour that demonstrates a selective defiance of product obsolescence through accumulating specific goods. The distinction made here is that collecting is a structured activity where the collector will seek items that are of specific interest, rarity or of economic or cultural value. Unstructured collecting is dealt with in the next section on embalming. [Refer to Section 4.3.3] The motivations behind collecting are highly varied. However, it is an involving and passionate mode of consumption (Belk 1995). A collector may simply maintain an informal interest in a type of product for no other reason other than 'liking it', or have a deeper emotional attachment – such as being linked to important memories recalling a past events, associations or a past aspiration of ownership (Chapman 2005). Economic reasons are another motivation for collecting.

The collected artefact becomes an investment that could potentially be traded in the future for profit (Gregson and Crewe 2003). In its most formalised expression, the collector will seek out particular items to complement or complete a collection. The collection of antique radios or electronic calculators can be a highly structured activity where the collection may be catalogued, archived or displayed. Often this form of collecting is targeted and measured in economic value or scarcity with the greatest accolade reserved for obtaining a collected artefact that becomes 'priceless'.

4.3.3_ Embalmers

Embalming is a term devised by the author to describe collecting activities that are informal and less structured than those outlined in the previous section. [Refer to Section 4.3.2] Embalming behaviours range from short-term storage of temporarily out-of-use products to habitual hoarding and the accumulation of obsolete, never-

used products. Many household products are awaiting use or reuse (Boyd and McConocha 1996). Attics, cupboards, spare rooms, garages and spaces under beds can conceal all sorts of products that have become obsolete in terms of current household needs but are retained in the belief that one day they will again become useful or valuable16. In many instances products can move in and out of use. Some kitchen gadgets and power tools are typically stored for long periods between short periods of frantic use. For longer periods of inactivity, when products enter a 'twilight zone', products may be 'embalmed' in boxes and bags (Shipton 2003), possibly off-site in any one of a growing number of self-storage centres[17].

A more acute form of embalming behaviour is hoarding, which can result in significant amounts of household clutter. Hoarding is often associated with the generation who grew up during and soon after World War II. Government austerity measures encapsulated by the catch phrase 'make-do and mend' galvanised a nation into stockpiling items to provide vital parts and materials to repair worn out clothing and household goods (H.M. Government 1943). In more recent times, a new extreme form of hoarding has been diagnosed. Compulsive hoarding has been recognised as a social pathology that has even been linked with psychological disorders including schizophrenia, forms of dementia and obsessive-compulsive disorder (Neziroglu et al. 2004; Steketee and Frost 2006).

[16] The technology research firm Accenture's study on mobile phone recycling found that 65 per cent of used mobile phone end up in drawers (Accenture cited in Nokia 2007).

[17] According to the Self Storage Association of the UK (SSAUK 2009) 230,000 customers use more than 250 centre located throughout the UK.

Figure 27: Embalmed products, awaiting reuse and displacing space originally designed for other purposes [photo: author]

4.3.4_Tinkerers

Many hoarders may also be tinkerers. 'Tinkerer' is a term that can be traced back the13th century; it's someone who mends kettles, pots and pans (Online Etymological Dictionary, 2008). In a contemporary setting a tinkerer is someone defined by his or her ability to repair or refurbish a product (Thomson 2008). A tinkerer's abilities may also extend to repurposing. [Refer to Section 4.3.1] Tinkering can bring a great sense of satisfaction and achievement from resurrecting a product from the dead. Many household products that have failed or show signs of wear can be repaired or refurbished with a fairly basic knowledge of product construction, materials, mechanisms or electronics. Those that are easy to disassemble or consist of relatively simple mechanisms are the most obvious candidates for tinkering. Nonetheless, an alarming number of household products are discarded with only minor functional or aesthetic problems (Waste Watch 2007). Many factors conspire to discourage tinkering – for instance, the increasing complexity of electronics, sealed unit sub-assemblies, use of tamper-proof or hidden fasteners, warning labels stating that 'warranty will be void' if tampered with, or that there are 'no serviceable parts inside'. Such factors collectively contribute to a declining willingness to tinker. Many small appliances such as hairdryers, toasters and food processors fall into this category. Failure of any one

component can terminate its lifespan. Moreover, it is sometimes not worthwhile tinkering with such devices as they essentially have to be destroyed to gain access to internal components.

Figure 28; If you can't open it you don't own it (Make 2009)

Despite these obstacles devised by manufactures, tinkering remains a widely practiced activity – either because of economic necessity, as is the case in many developing countries, or as a leisure activity in more materially affluent countries. Increasingly, magazines and specialist websites are devoted to exploring modern-day tinkering. The magazine *Make: Technology On Your Time* celebrates a contemporary DIY culture of tinkering. Their stance is summered up by its slogan: "If you can't open it you don't own it." (Jalopy 2005: 154) and by its 'Bill of Rights' to tinker. [Refer to Appendix 1] Voiding warranties and messing around with the internals of consumer products is encouraged. However, such magazines and websites are careful to make disclaimers on undertaking such activity:

> *'We are not responsible for electronics damaged or warranties made void as a result of following the information contained herein; this website is for informational purposes only. We must recommend against, of course, the dismantling of electronic devices. Doing so could damage them or void their warranties'* (Take It Apart 2009).

Despite such sober warnings, many magazines and websites rejoice in tinkering activities. [Refer to Figure 28] Tinkering can also be a low-technology activity. Mark Thomson (2008) the self-appointed 'Professor of the Australasian Institute of Backyard Studies' celebrates the 'art' of tinkering through a series of books and a website that explores the ethnography of the Australian male and his shed. He

draws on personal accounts of backyard tinkering and the lost skills in making. His guiding principles confirm the non-too-serious nature of his endeavour, but reaffirm a range of qualities that help define tinkering. These include being practical, working with everyday things and the collection and hoarding of useful stuff. [Refer to Appendix 1 for a further account of Thomson's guiding principles for tinkers]

4.4_Societal factors

Societal factors are extremely important in determining product lifespans. They are the socio/cultural structures and economic systems that help shape societal norms, values and behaviours. Despite the evidence that these factors often contribute to locking-in our behaviour and actions of our throwaway society, counterpoints do exist that demonstrate qualities that can prolong product lifespans. Characteristically, they operate at a macro level (of this proposed three level categorisation) as the infrastructure or plumbing in which product lifespans actions and behaviour take place. Factors discussed in this section include: fashion cycles, design classics, secondary markets, information networks and product service systems (PSS).

4.4.1_Fashion cycles

Despite fashion being a significant cause of obsolescence, it can also play a positive role in prolonging product life-spans. Fashion is often cyclical; past fashions are revived, rediscovered and appropriated by contemporary consumer culture. The embalmers, hoarders and collectors, as described above [Refer to Section 4.3.2 and 4.3.3], may be motivated to pursue their respective activities by the possible return of a past fashion. In the domestic environment there are many examples of revived fashion styles, from mock-Georgian architecture housing, 1950s Scandinavian furniture to retro-styled cars. While examples in consumer electronics are less common, due partly because of technological change, examples do exist. For instance, the JVC Spaceman television – an iconic product of the late 1960s and early 1970s, when the space race reached its zenith with the NASA's Apollo programme – is now a rare collector's item. Its current market value has considerably eclipsed its original value. Early Bakelite appliances are also keenly sought after. A bakelite desk phone from the 1940s, representing the retro-chic of 1940s film noir, is still encountered in many vintage and antique shops, while Art Deco bakelite valve radios are keenly sought after and actively traded.

Retro fashion styling has been picked up by several manufactures as a marketing strategy. Tapping into this yearning for nostalgia, the UK firm Roberts produce a range of portable radios that are styled incarnations of their earlier 1950s portables. [Refer to Figure 29] However, the technology and materials bear little resemblance to the original design. Roberts' marketing declares: 'Sound for Generations', highlighting the importance of retro styling as a part of the brand heritage (Roberts 2006).

Figure 29: Manufacturing nostalgia. The Roberts Revival r250 radio (Roberts 2006)

4.4.2_Design classics

Some products attain a long lifespan through recognition as design classics. The appellation can be achieved through reputation of the designer, critical acclaim by design commentators, scarcity and market desirability. A design classic can be defined as having qualities including lasting influence, enduring cultural significance and remaining unchanged since its design (Phaidon editors 2006). Design classics often attain high prices when traded, especially when keenly sought by collectors. Examples such as the Morris Mini by Alec Issigonis, the Ant chair by Arne Jabsobsen and the Tizio table lamp by Richard Sapper are the subject of many books, with authors eulogising about the significance of one design over another (Phaidon editors 2006; Albus et al. 2004; Baker and Baker 2001; Abendroth et al. 1999; Sparke 1998; McDermott 1997). However, the term 'design classic' is often deemed problematic, and has been devalued through

arbitrary overuse in our contemporary culture. Often products are launched as 'design classics' even though their long-term survival, reputation and significance remain highly speculative.

One retail company that tries to negotiate such concerns is Manufactum (2005). It claims many items in its mail order catalogue are 'classics' which have stood the test of time and will outlive any trend or fashion. [Refer to Figure 30] This company markets its products in terms of functional and fashion durability[18]. Their strategy is based on the pursuit of attaining design 'quality'. This quality includes many tangible and intangible aspects of a product, from emphasising the quality of manufacture to more abstract values that touch on emotional, traditional and cultural significance. They emphasise relationships between designer, producer, distributor and the customer. Manufactum's catalogue often tells a background story of featured products highlighting the providence of the design and manufacturer.

Figure 30: Manufactum products, household goods that are selected for fashion and functional durability (Manufactum 2005)

4.4.3_Markets, traders and auctions

As previously noted, market forces are implicated as a central cause of product obsolescence, but certain markets can also offer a means of prolonging product lifespans. For instance, secondary markets such as auctions, classified advertisements and car boot sales offer a range of opportunities for extending

[18] Fashion durability is a form of psychological durability (Chapman 2005; Mugge et al. 2005) See also footnote 2 "relative" obsolescence.

product lifespans (Gregson and Crewe 2003). [Refer to Figure 31] Products that are no longer wanted or needed by one owner can be sold, given away or donated to others, harnessing the market economy to prolong product life.

In recent times, the Internet has proven to be a particularly potent tool for enabling secondary markets to connect owners of obsolete products with potential new owners. On websites such as eBay and Freecycle, people trade, exchange or donate products. eBay, in particular, has been enormously successful in popularising the trading of second-hand goods. With 181 million registered users worldwide, it has 3 million items listed for sale at any given time, with consumer electronics being one of its top seven traded categories (Ellis and Haywood 2006; eBay 2006). Despite the presence of many new goods being offered for sale on eBay, a healthy proportion of second-hand goods are also traded.

Figure 31: Car boot sale. A well established secondary market system that enable obsolete products find a new owners. [photo: author]

4.4.4_Information networks

As well as the importance of internet sites such as eBay, other forms of information technology (IT) offer opportunities to address product obsolescence. In *When Things Start to Think*, Neil Gershenfeld (1999) points to a future in which the digital world merges with the physical world driven through the proliferation of network

technologies and the emerging digital infrastructure. Not only will computers continue to talk to each other, but other products – from toasters to washing machines – will join the conversation. Bruce Sterling (2005) goes a step further by suggesting that an emerging 'internet of things' will enable the existence of 'spimes'. A spime is a product that is conceived from within a network. Its qualities include its ability to be made by digital fabrication (rapid prototyping processes). It has a unique digital identity that can be digitally tracked (geo-located) and searched for through a search engine. In effect, spimes are products that could be traceable and managed throughout their lifecycle.

Many product operations are increasingly controlled through software, as opposed to traditional hard-wired electronics or electro-mechanical functionality. If a product can be programmed, the opportunity exists for it to be reprogrammed to take advantage of new operating conditions or technological improvements. By simply upgrading the software a product's life can be renewed. People are familiar with this concept for computers in the form of software upgrades. But what about other products? The manufacturer Miele offers an upgradeable operating system in its dishwashers, allowing for changes in washing cycles, new washing chemicals and better power management. Similarly, other products could benefit from this approach. Sewing machines, for example, could be upgraded to take account of new fabric, threads and stitches (Ryan 2004).

RFID (Radio Frequency Identification) is a widely used technology in manufacturing and retail distribution supply chains. It could also be used to access embedded information within a product at various points during its lifecycle (Simon and Dixon 2003). When a consumer electronics product is passed on as a hand-me-down or traded on a secondary market, the new owner is presented with a number of concerns. What is its condition? How does it work? Can it be upgraded/repaired? RFID-embedded product intelligence could be used to provide onboard user manuals with information about supplier, spare parts and a log of the product's condition This could include hours of use, fault detection log and energy consumed (Ryan 2004). Similarly, QR codes[19] a two-dimensional matrix barcode system can enable product information to be decoded using nothing more than a java- or Symbian[20] - equipped mobile phone.

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[19] QR (quick response) codes are common in Japan, were they were first developed in 1994. They offer a much higher information density than standard barcodes while sharing similar benefits.

[20] Java and Symbain are languages commonly used to program smart phones and PDAs

4.4.5_Product service systems

The concept of product service systems (PSS) is "a marketable set of products and services capable of jointly fulfilling a user's need" (Goedkoop et al. cited in Mont 2004: 18). PSS strategies can displace the physical ownership of products by offering a service-based solution to customers. Such strategies may include product-leasing arrangements that encourage businesses and manufacturers to supply products that are capable of long service (Van Hinte 1997). It has attracted much recent interest from designers exploring sustainable design solutions (Manzini and Jégou 2003; Stahel 2001). For design, the emphasis is to focus on addressing customer needs rather than focusing on the physical design of a product. PSS also requires a different approach to business and social arrangements, such as leasing, subscription services and the shared ownership of products. Leasing, already a well-established business-to-business model, has a proven potential for prolonging product life (Kerr 1999). Other forms of PSS include shared ownership schemes such as car sharing, where membership entitles access to jointly owned facilities thereby maximising product use during its lifespan. PSS can potentially encourage businesses and manufacturers to supply products that are capable of long lifespans (Manzini and Jégouj 2003; Stahel 2001; van Hinte 1997). In such instances lifespan may be more meaningfully measured as service use – its intensity of use during its lifespan – as opposed to lifespan in ownership years.

4.5_Product lifespan opportunities

This chapter has attempted to demonstrate that there are products, user behaviours and societal systems that can prolong product lifespans with many that are informal or unplanned. Technological change and market systems that conspire to shorten product lifespans can also be harnessed to prolong life. Similarly, specific types of individual behaviour can also offer a model for changing social attitudes and behaviours towards product lifespans. From the many examples presented in this chapter opportunities arise to develop, formalise and incorporate these into design and business practices.

4.6_Conclusion to Part 1

Part 1 of this thesis has reviewed a diverse range of literature in consideration of two specific research questions:

Q1. What shapes the consumption and the obsolescence of products?

Q2. What can be learnt from existing examples of prolonged product lifespans?

In regard to question 1, it can be concluded that patterns of consumption and obsolescence of products are shaped by a complex interplay of factors including sociological, psychological, technological and economic factors. Despite the evidence that in many sectors product lifespan are getting shorter, there has been relatively little research into product lifespans. It is observed that consumption is socially constructed. Products often become obsolete owing to 'relative' factors determined by psychological (mind), economic (money), technological (matter) reasons - and less from the 'absolute' physical failure of a product.

Chapter 4 specifically addresses question 2. Examples of product lifespans are identified, categorised and described in detail. Many of the examples are unplanned and informal. They can be categorised into three groupings, Product (features), Individual user (behaviour) and Societal (socio/economic). What is revealing is the diversity of examples and approaches of unplanned actions that can prolong product life. By identifying reasons behind obsolescence and the many unplanned examples of prolonged lifespans subsequent questions emerge:
Q3. Can specific examples of prolonged product lifespans be described and structured into formalised strategies?

Q4. Can product lifespan strategies be successfully applied to design projects?

Part 2 of this thesis considers these questions in detail. It commences with a description of the research methodologies that underpin this structured enquiry.

PART 2: Research Projects

5_Research methodologies

This chapter describes the research perspective, methodology and methods undertaken within this research in response to investigating the questions proposed in Chapter 1. [Refer also to Figure 1] The rational for this research is to investigate and understand design factors that can determine the product life and how this knowledge be applied to design projects. It contains elements that can be described as being 'practice-led' in that the research leads to the understanding about design through design practices (CCS 2008). Equally, it could be described as 'research through designing' (Pedgley and Wormald 2007) where practical design projects are informed by and build upon previous theory and knowledge as found in the literature. The rationale for choosing a research-through-design methodology has been determined by the research questions and completed objectives. [Refer to Figure 1] Further to this, this research it is about identifying and developing new design strategies. As such, the adopted research methods include design practices. The chosen methods offer illustrative and instructive examples of the identified design strategies.

This chapter starts with a brief discussion on the research perspective. This affects the development and execution of this research and has implications on the findings. The adopted methodology and resultant research methods follows. This includes discussion of the design process as a research methodology which is presented as a sequence of events as applied to the author's research through designing projects. The structure and sequence of research activities include three separate research projects,

1. A seminar design activity,
2. A pilot design product with design students
3. Three design projects undertaken by the author.

5.1_Research perspective

Established fields often adhere to clearly defined research perspective (Guba & Lincoln cited in Mont 2004). For example, the traditions of science are grounded in a positivist epistemology that claims to be 'objective' in its understanding of the observed world. On the other hand, other academic fields such as the humanities and social sciences often find such perspectives inadequate in enabling a coherent understanding of the world. To illustrate this spectrum, post-modern critical theorists position themselves at polar opposites to the objectivism and

reductionism of the traditional sciences by adopting a 'subjective' research perspective.

This research is framed within the relatively recent and emerging fields of design studies and sustainable consumption. Both often typify a multi-disciplinary research perspective that attempts to accommodate a diverse range of knowledge emanating from many discipline areas so as to deal with the complex interplay of social, environmental and economic dynamics that shape our world. Such an approach tries to accommodate the objectiveness of scientific positivism to the conjectural subjectivism of post-modern theorists where findings may be transactional and mediated interpretations.

Some commentators go further, calling for the need to transcend specialist discipline areas within a multidisciplinary setting by adopting a 'trans-disciplinary' approach (Harding 1998). A trans-disciplinary approach draws on multiple disciplines. It spreads horizontally across a broad knowledge base, intersecting vertical spikes of specialist expertise. It has been argued that it is the positivism of scientific reductionism that has shaped our society since the industrial revolution and has led us to the current crisis of sustainability (Margolin 1998). Isolated specialist knowledge and reductionism are claimed to be inadequate to deal with the complex interrelationships between society, the environment and the economy (Capra 2002).

This research embraces the trans-disciplinary approach. This requires a more accommodating research paradigm than the reductionism of positivism or contextualised criticism of subjectivism. It adopts a constructivist research perspective. Crotty (1998) defines constructivism as,

> *"all knowledge, and therefore all meaningful reality as, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context".*

The following diagram [Refer to Figure 32] identifies key qualities that relate to the main research paradigms that have been discussed in this section.

	Positivism	Post-positivism	Constructivism	Subjectivism
Ontology	'Real' realities	Critical realism	Socially constructed reality	Specific context constructed realities
Epistemology	Objectivist findings	Objective/ conjectural findings	Transactional / value mediated findings	Subjective created findings
Example	Gravity A 'natural law' that can be scientifically established through observation, experiment and comparison.	Quantum physics The 'uncertainty' of behaviour of sub-atomic particle. Observed particles are altered by the very act of being observed.	Semiotics The investigation of meaning making and meaning signifying Semiotic methods can reveal different levels of meanings and, sometimes, hidden motivations	Gender or Feminist studies Meaning is constructed through a lens pertaining to a particular socio/cultural perspective

Figure 32: Research perspectives (Based upon Guba and Lincoln 1998; Crotty 1998)

Central to this research is to understanding factors that can determine the lifespan of consumer electronic products. Obsolescence occurs mostly because of 'relative' than rather than 'absolute' factors (Granberg 1997 cited in Cooper 2004). [Refer to Section 2.6 for a further explanation of relative and absolute obsolescence] The amount of abandoned but still functioning consumer electronics attests to this assertion. To understand the socially constructed 'relative' factors behind obsolescence a constructivist perspective is adopted.

With the inclusion of the author's own design projects within this practice-led design research, the author becomes 'involved' in what is being studied. A positivist approach would require an objectivity in which the researcher is said to exert no influence over what is being studied. This is unlikely under the circumstances. Thus such methods have a constructivist perspective. Findings are mediated through the design process where understanding comes into existence through an observer's engagement with what is being studied.

This research offers a counterpoint with regard to two other notable PhDs in this field. Anne Marie Chalkley (PhD) and Nicole van Nes (PhD) have both investigated product lifespans and environmental impacts. Chalkley's (2003) contribution is to identify when it is ecologically beneficial to retire a product in favour of a new more

energy-efficient one. Her research adopts a more positivist perspective through reliance on quantifying, through the use of numerical formula, when it is optimal to replace one product for another. van Nes (2003) specifically addresses replacement decisions of products by adopting a multi-disciplinary approach. Initially, she sets out to assess the environmental desirability of longer lasting products by quantifying 'environmental desirability' through use of methods not dissimilar from Chalkley's. However, she shifts methodology to understand 'replacement motivations' through a combination of quantitative and qualitative research methods. Of most interest to this research is her research-through-design methods in response to the research question: "How to influence the replacement decisions through product design?" (van Nes 2003: 133). van Nes undertakes methods that include a design workshop and illustrative design projects. Through her research, she demonstrates how design projects can be deployed as a research method in gaining an understanding of the lifespan of products.

5.2_Methodology

This research situates itself between positivist and subjectivist research paradigms. For reasons outlined above it adopts the epistemological position that knowledge is 'constructed'. The methodology of this research exits within a multidisciplinary context. It establishes "the strategy, plan of action, process or design lying behind the choice and use of particular methods" (Crotty 1998: 3).

It first seeks to understand existing knowledge and identify examples of prolonged product lifespans by reviewing the literature across three broad fields: product obsolescence, consumption and design. Following this review of empirical and theoretical studies, the next phase of this research methodology was planned and refined to best meet the aims and objectives of the research. This 'research through design' phase began with the involvement of participants in a seminar workshop developing solutions to product obsolescence. A pilot design project followed, leading into the main body of research that features the author's own design projects. [Refer to Chapter 8] The research methodology is summarised as a sequence of activities. [Refer to Figure 33]

Methodology	Method	Activity
Review of Empirical and Theoretical studies 'What is?'	Literature review	Review literature Review of examples of product, behaviours and societal factors that demonstrate prolonged life-spans.
Research-through-design 'What if'?'	Seminar workshop activity	Structured activity with workshop participants
	Pilot design project Author's design projects	Apply design strategies within specific activities and projects Document and analysis

Figure 33: Adopted Methodology and Methods

5.2.1_Research Methods

As determined by the methodology described above, specific methods have been chosen to best reflect the aims and meet the objectives of the research. These methods have been determined as optima tol best address key research questions. A summary of the research methods and their description is shown below. [Refer to Figure 34]

Research question	Method	Description
Q3. Can specific examples of prolonged product lifespans be described and structured into formalised strategies?	Seminar workshop activity	Design I Behaviour seminar. Participants considered new and novel ways to prolong product life of assigned products.
Q4. Can product lifespan strategies be successfully applied to design projects?	Pilot design project	Design project with design students. Application of specific lifespan strategies to design projects through a structured design process.
	Design projects	Author's design products. Application of specific lifespan strategies to design projects through a structured design process. Project evaluation by selected authorities on product sustainability.

Figure 34: Summary of research methods

The design process as a method is evident in each of the research projects. In the author's design projects it is explicit and documented as a stage-by-stage process, while in the Using and Consuming seminar workshop it is embedded. It can be determined that a design process of some nature was adopted by participants to arrive at 'designed' outcome to the set tasks. [Refer to Appendix 7]

5.2.2_Researching through design

This sections features a discussion on the adopted research-through-design methodology and defines 'design' and how it is applied within this research.

This research asks questions about the role of design, which is identified as being complicit as a cause of obsolescence. While societal and individual behavioural factors are also prominent, it is design that often mediates these values thought technologies, styling and materials. To develop an understanding of the boundaries of design in determining or thwarting obsolescence, design practice has been included as a central feature in this research. It is believed that practical design projects can offer a means of developing understanding about new knowledge on designing for product lifespans. Research-through-design probably best describes this process, which explicitly refers to research in which "one engages in one's own designing". (Pedgley and Wormald, 2007: 72).

Design projects enable a development and exploration of the knowledge gained from the literature review, and brings to this research a number of insights that are central to its aims and objectives. Design enables a landscape for expanding knowledge. "Unlike scientists who describe how the world is, designers suggest how it might be" (Lawson 1997: 112). Design projects allow for a 'creative reasoning' (Whiteley 2000: 23) where design activities such as sketching and modelling can enable a problem to be understood. Designers can make a unique contribution to research by creating things that allow other people to see the world differently (Rust, et al. 1999). The design process documented within this research (sketchbook concepts, design development drawings and models) offers a record of the application of product lifespan strategies to design projects enabling analysis and evaluation.

At this stage it is important to define what constitutes design research and how it differs from design practice. In dealing with the shifting ground of what constitutes design research, many commentators return to Bruce Archer's way of framing design research in one of three ways: research 'about' design, research 'through' design, and research for the 'purposes' of design (Archer, 1995[21]). Again, Bruce Archer offers robust guidance on defining design research:

[21] Christopher Frayling has also often been credited as the originator of this model.

> *"Design research is systematic enquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems"* (Archer cited in Pedgley and Wormald, 2007:74)

Although design projects undertaken within this research follows a well-established process, as typically found in industrial design practice, the context with which this activity is undertaken contains additional qualities. According to Nigel Cross and David Durling, both council members of the Design Research Society (DRS), for design to qualify as research, it should satisfy a range of specific criteria. They offer a range of qualities that distinguish what is – and isn't – determined to be design research. [Refer to Appendix 2] These include: research asks questions, selects appropriate methods, enables analysis and discovery, and is locatable and searchable. In totality, the principle feature distinguishing research from non-research is a "systematic inquiry which is reported in a form which allows the research methods and outcomes to be accessible to others" (Allison et al. 1996: 21 cited in Pedgley et al. 2007).

5.3_Design – object or process?

> *"Design is to design a design to produce a design"* (Heskett 2002: 5)

Inherent within an understanding of what constitutes a role for design and its relationship to this research is a discussion of design itself. The quotation above by John Heskett teasingly but observantly suggests that design can be many things. It can be a verb 'to design', it can be instructional documentation as in drawings, models and specifications, or it can be a noun, a physical manifestation, 'a design'. While the term 'design' is often reserved for discussion or judgement of a physical object, it is the former meaning of the word that is important to this research. Design is often used as a noun . . . for example, 'that chair is a good design'. Such usage is common among professionals and non-professionals when expressing an opinion (objective or otherwise) on a 'designed' artefact. Such use of the word offers little help in revealing the role design plays in this research. To understand that role, the term 'design' is of most useful when considered as a verb – that is, to describe the process and not an outcome.

A common misconception held by many casual observers when confronted with the idea of designing is that there is little evidence of any process. Design just happens and is undertaken by those special few 'creative types'. There are many possible reasons for this misunderstanding, including that the process is often not

explicit or revealed to the casual observer. It is often an internalised process and not often revealed for scrutiny (Lawson 1997; Park and Talbot 1999). A persistent idea is that the few chosen designers and artists have a distinctive and special role in our culture as creative individuals helps maintain this myth. What is often not revealed is a team of designers who work according to a co-ordinated and structured process.

Although there is little consensus on what defines the exact stages of a linear or non-linear arrangements of a design process (Lawson 1997) there are consistent models or progressions that are widely recognised in industrial design practice. The following section describes a typical product design process that has been adopted for design projects undertaken within this research.

5.3.1_The design process

The design process as applied to design projects within this research is structured in stages. It is presented as a linear process, but inherent within any design process are feedback loops, as well as leap-forward loops, that are accommodated to varying levels of formality. These can be a verification and assessment of each design stage against set criteria, or be more informal and iterative processes where the designer is moving back and forth, anticipating potential next-stage conflicts and adjustments so the design outcome can be optimised.

In simple terms the stages adopted within this research are:

1. The brief
2. Concept exploration
3. Design development
4. Design documentation
5. Evaluation

The brief

The design brief is recognised as one of the most important stages of any design project. The design brief establishes the goals to be achieved. It seeks to set the right question(s) so the best design solutions can be sought. It should not be prescriptive, but should clearly state criteria to which the final design should be considered and measured against. Responding to the set problems within the design brief the designer will commence a 'discovery' phase of research and information-gathering to best understand the project before moving onto the next stage – concept exploration.

Concept exploration

Quick visualisation skills, including sketching and drawings are the hallmark of this phase. The emphasis is on quickly and efficiently capturing and communicating numerous ideas thereby maximising the available time on discovering and exploring the greatest range of design possibilities. Not without some surprise this is often thought to be where a designer's unique creative skills come to play.

Design development

From a selection of concepts produced during the previous stage, a selection process takes place to eliminate weaker designs. A preferred design, or in some cases a combination of features from more than one design, is decided on as being worthy of further development. The decision on which concept design to proceed with is often made in consultation with the client. The design team will then develop the concept within the agreed design envelope leading to the resolution of all critical details. Typically, the designer will produce a range of outcomes including a G/A (general assembly) drawing, rendered visualisations, computer models and foam or card model of the preferred design.

Design documentation

At this stage the design is frozen to enable engineering development to take place. The primary form, function, materials and component configuration are agreed on to enable the production of design detail documentation. Depending on the complexity and characteristics of the design, this may include a sequence of part drawings, 3D modelling data, appearance models or prototypes and written specifications. For a design consultancy, this stage is often the culmination of the project resulting in a handover of the documentation to the client. For an inhouse design team they will often continue involvement and management of the project into the next phase, evaluation and ultimately implementation.

Evaluation

Evaluation may entail physical testing of a prototype to ascertain functional and material performance. Similarly it may involve consumer testing with user groups, marketing or industry specialists. The design process may be evaluated to determine its success in meeting the objectives outlined in the design brief, and efficiency in delivering the final design. Evaluation will often occur as feedback throughout the design process, enabling the designer or team to make adjustments along the way. This was the final phase of the design process undertaken within this research. Selected industry experts performed the evaluation by responding to a set of questions.

5.4_ Design projects

This section describes specific design methods applied to each of the projects undertaken within this research. Each method has been chosen to meet the key objectives through addressing specific research questions.

Objective 3, *Organise specific product features, consumer behaviours and societal factors that can prolong product lifespans*, is addressed in the Using and Consuming design project. [Refer to 5.4.1 below] While objective 4, *Select and apply specific lifespans strategies to structured design projects*, is considered in a series of subsequent research-through-design projects. [Refer to 5.4.2 and 5.4.3] Linked to these objectives and addressed by each research method are key research questions. [Refer to Figure 1] The relationship between research questions and each research project is discussed below.

5.4.1_Using and Consuming research method

Using and Consuming was the first design project conducted as a part of this research. It took the form of a structured design activity, with participants attending the 10th Sustainable Design Network seminar, co-organised by the author. [Refer to Appendix 4] Participants were challenged to undertake two interrelated design tasks. Using a set of predetermined reference products, including consumer electronic items, participants were challenged to consider how to prolong product life. The aim of the activity was to discover if any new or novel product lifespan strategies would arise. This research task addresses the research question Q3, *Can specific examples of prolonged product lifespans be described and structured into formalised strategies?* This required participants to adopt roles, as a designer (of a specified product) and then later as the user (of another specified product). Participants were encouraged to explore creative and collaborative approaches to prolonging product life. They were encouraged to record their responses using supplied paper and pens. A prompt sheet was provided offering possible reasons for obsolescence [Refer to Appendix 6] within an allotted time. This preliminary study sought to consider the following supplementary questions:

1. *Are there similarities in response between assuming the role of a consumer and assuming the role of a designer to specific products?*
2. *Are there any new or novel approaches for prolonging product life not previously identified?*
3. *Is there commonality of life-span approaches between product types?*

[Refer to Chapter 6 for a further detailed description of the event]

5.4.2_Pilot design project research method

This second research project was undertaken as a pilot for the third and largest component of this research. It involved product-design students participating in a design project. The pilot project required each student to apply a specific product lifespan strategy. This project was integrated into their degree course project work and contributed to their course assessment.

The pilot project attempts to reveal – through the application of specific strategies – how they can be embedded within a design project. [Refer to Section 7.2] The project also enabled adjustments and refinements of the methods to be applied to the third and largest project undertaken as a part of this research.

By undertaking a design project an assessment can be made about how well student designers understand and can apply such strategies. The aim of this project is to learn through the application of specific product life-span strategies how they can be embedded within the design process. It seeks to consider the following supplementary questions:

1. *Can proto-professional designers successfully apply specific product lifespan strategies to design projects?*
2. *What can be leant from applying specific strategies within the design process?*

5.4.3_Design projects research method

The third and most significant project undertaken within this research includes three separate design projects. The design projects offer a 'prescriptive' example of each strategy as applied to a design project to complement the 'descriptive' analysis of each strategy as offered elsewhere in this report. [Refer to Chapter 2 and Chapter 8] Each project explores one of three identified product lifespan strategies as applied to a practical design projects. Each strategy is embedded within the design process leading to an illustrative product example. The realisation or level of completion of each project varies slightly. A sufficient level of completion is required to enable project evaluation and analysis. For instance, where a strategy contains strong technical attributes the product outcome should reflect a level of technical resolution. A user-centred technical resolution is less important for an applied strategy.

These design projects seek to answer the research question Q4, *Can product lifespan strategies be successfully applied to design projects?* In order to respond to this question, industry experts were selected to evaluate each project prompted by the following supplementary questions.

1. Do *you believe that this project successfully demonstrates the application of the proposed strategy of Piggybacking/ Reassignment / Scripting?*
2. *Can you think of other products that can benefit from this strategy?*
3. *Can you suggest improvements, shortcomings, oversights or other things to consider?*
4. *Which project do you think is the most successful and has the most potential in prolonging the lifespan of consumer electronic products?*

A further account of the evaluation process is available in Section 8.1.8.

6_Design I Behaviour: Using and Consuming

Figure 35: Using and Consuming research event [photo: Paul Micklethwaite]

Using and Consuming was the first research project conducted as a part of this research. It took the form of a structured design activity with 16 participants representing about half the delegates attending a design seminar Design I Behaviour, co-organised by the author[22]. The project challenged seminar participants to consider new and novel ways to prolong product life of an assigned set of products in response to *Q3. Can specific examples of prolonged product lifespans be described and structured into formalised strategies?* Building upon examples already revealed in the literature review [Refer to Part 1], the project also responds to the following supplementary questions:

1. *Are there any new or novel approaches for prolonging product life not previously identified?*
2. *Are there similarities in response between assuming the role of a consumer and assuming the role of a designer to specific products?*
3. *Is there commonality of lifespan approaches between product types?*

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[22] Design I Behaviour, the 10th Sustainable Design Network seminar was held at the Design Centre, London on April 12, 2006.

6.1_Design I Behaviour seminar

The Design I Behaviour seminar brought designers, design researchers and academics together to explore how design could influence sustainable behaviours. [Refer to Appendix 4] Influencing patterns of sustainable behaviour remains a field relatively unexplored by designers. This emergent field was explored through presentations, activities and discussion as illustrated in the event agenda. [Refer to Appendix 5]

6.2_Using and Consuming

The research project Using and Consuming ran for 1 ½ hours during a parallel afternoon session of the one-day seminar. During this session, participants were challenged to consider new and novel ways of prolonging product lifespans of specific products. The structured activity consisted of 16 randomly selected seminar delegates that included designers, design educators and academics.

6.2.1_Design activity

Participants were requested to form pairs, then choose one of seven provided products. The selected reference products on offer were: car radio/cassette, hair clippers, 3½ computer disc, electric iron, LEGO kit, mobile phone and portable radio. [Refer to Figure 36] These products offered a collection of new, heavily used and technologically obsolete products. Most, except the LEGO kit and hair clippers, could be classified as consumer electronics. The rationale for including non-electrical products was to offer a counterpoint for comparison with the electrical ones and to ascertain if there were significant differences between the two.

Figure 36: Selected reference products [photos: author]

The activity consisted of three stages:

1. Assuming a role as the consumer (user)
2. Assuming a role as the designer
3. Presentation and discussion

Role as consumer

When seated with their selected product and equipped with A2 paper and pens, each participant pair was challenged to assume the role as the user, of their chosen product and consider three questions:

1. What are the reason(s) for obsolescence?
2. What would be your behaviour in response to the reason(s) for obsolescence?
3. What are your options for prolonging product life?

Role as designer

Upon completing the first task, after approximately 25 minutes, participant pairs were requested to swap products and comment sheets with another pair and

resume the activity, but this time assuming the 'role as a designer' of their newly acquired product. They were encouraged to review comments made by the first pair and document their re-design proposal using the supplied materials. In their assumed role as the 'designer' participants were asked to consider:

1. How would you re-design this product?
2. How would you design 'out or in' behaviour around the identified issues of product obsolescence?

Figure 37: Using and Consuming activity [photo: Paul Micklethwaite]

Presentation and discussion

On completion of the role-playing exercise, participants were offered the opportunity to present their ideas (as posters) and respond to discussion. Posters, photographs (of the event) and researchers' notes were collected for compilation

and analysis. A compilation of these items can be found in the Appendix 7. A summary of the event is shown below in Figure 38.

Activity instructions	Addressed Questions
Choose a product. Assume the role as the product user and then as the product designer. What are the options to prolong the lifespan of a obsolete product? What would be your response (first as a user, then as a designer) to the product obsolescence? What are your options for prolonging product lifespans?	1. Are there any new or novel approaches for prolonging product life not previously identified? 2. Are there similarities in response between assuming the role of a consumer and assuming the role of a designer to specific products? 3. Is there commonality of lifespan approaches between product types?

Figure 38: Summary of Activity

6.3_Findings

A response to each question [Refer to Figure 38] is detailed below. [Refer also to Section 5.4 for a more detailed account of the formulation of these research questions]

1. Are there similarities in response between assuming the role of a consumer and assuming the role of a designer to specific products?

This study found there were two instances out a possible 14 where participants, assuming the separate roles – first as consumer, then as designer – had suggested similar product lifespan strategies. Both instances are related to disposal, including exchange for another products, donation or selling on a secondary market, such as eBay. However, in most instances, the response of Role of Consumer and Role of Designer show little similarity. The table below [Refer to Figure 39] summarises key findings, with the last column indicating correlations of responses. For a further documentation of the outcomes for each product refer to Appendix 7.

Product	Consumer response	Designer response	Strategy correlation
	Reuse and mix with other Lego Sell on EBay Store in cupboard	Exchange kit – Lego website Offer new and alternative designs 3D printer to make new parts Adolescent and Adult Lego	Donation/Secondary markets
	Store in drawer Trade-in	Exchange service Exquisiteness; wood and silk panels	PSS - trade-in exchange service
	Give away / Donate Clean up Secondary use in shed or attach to bicycle	Design entirely new product	None
	No data	Interchangeable covers (facia) Design entirely new product	Not applicable
	Repair with supplied parts Replace with electrical version Keep for future use	Redesign 'Alessi' style with character [pic] Promote to professionals; Barbers and Hair dressers	None
	Keep for future data recovery	Replace with centralised online data storage facility	None
	Repair (power cable) Clean, descale Store in cupboard Give away, Donate	Laundrette multi-service; including ironing, iron rental and repair service	None

Figure 39: Summary of responses to chosen products [photos: author]

2. Are there any new or novel approaches for extending product life not previously identified?

Technological obsolescence was the most common type of obsolescence identified for each product. This was to be expected especially for consumer electronics and is consistent with other findings regarding obsolescence (Granberg 1997 cited in Cooper 2004). Whilst some of the responses were found to be similar to other documented product life-span strategies, participants demonstrated an ease and proficiency with proposing new and novel solutions. Many creative and novel ideas for prolonging product life-spans were proposed. Since many of the participants are designers or associated with professional or academic design enquiry many were able to communicate their ideas through sketching.

A number of creative proposals could be categorised as PSS (Product Service Systems). These solutions entail the displacement of the existing product by either a new product/service or supported by a service business model thereby enhancing its functional life-span. One of the most novel responses was the proposal for a 3D printer to enable the fabrication of replacement parts. Another theme that reoccurred was that of enhancing product quality. For instance enhancing a mobile phone with 'wood and silk panels' or 'redesign in an '*Alessi* style character'. The table below matches participant's proposed strategy with existing documented strategies. [Refer to Figure 40]

Product	Respondent proposed solutions	Strategy Category
Lego kit	Exchange kit – Lego website	PSS (Product Service System)
	Offer new and alternative designs	Modularity
	3D printer to make new parts	Adaptive and Co-design
	Adolescent and Adult Lego	Upgrade
Mobile phone	Exchange service	PSS (Product Service System)
	Exquisiteness – wood and silk panels	Emotional Durability – material value
Radio	Design entirely new product	Not applicable
Car cassette / radio	Interchangeable covers (facia)	Upgrade
	Design entirely new product	Not applicable
Clippers	Redesign 'Alessi' style with character	Emotional Durability – product personality
	Promote to professionals - Barbers and Hair dressers	PSS – B2B business model
3 ½ computer disc	Replace with centralised online data storage facility	PSS – dematerialise into virtual memory
Electric iron	Laundrette multi service - including ironing, iron rental and repair service	PSS – dematerialise, rental and repair

Figure 40: Participant strategies matched to existing strategies

3. Is there commonality of life-span approaches between product types?
Many of the 'role of consumer' responses involved disposal, giving away. Selling or donation to charity was the second most frequent response. Such actions could be summarised as discarding strategies, where the owner attempts to find a new owner for their obsolete products. Assuming the 'Role of Designer' the most frequent response involved variants of a Product Service System (PSS). This was found to occur in five out of the seven reference products with the specifics of each PSS solution varying enormously. However, the consistency of PSS proposals as applied across a rage of reference products including electrical and non-electrical products is significant. This is consistent with the literature on PSS as it often makes mention of prolonging product life-spans (Manzini and Jégouj 2003; Stahel 2001; van Hinte 1997). In addition, many of the seminar participants would be familiar with PSS concepts that may have shaped their responses. The table below illustrates the frequency of occurrence by category product life-span strategies proposed by respondents. [Refer to Figure 41]

PSS	●●●●●
Emotional Durability	●●
Upgrade	●●
Modularity	●
Participatory design	●

Figure 41: Frequency of proposed strategies

6.4_Evaluation

Of the new and novel proposed solutions, some appear quite plausible while others remain highly speculative. Participants demonstrated an ease and proficiency with proposing new and novel solutions in making decisions on assessing obsolete products. Their proficiency in proposing solutions could be partly attributed to their familiarity with the design process. Many of the participants are designers or are associated, in some capacity, with design theory or practices. A potential shortcoming of the study was that, by assuming roles – first as consumer, then as designer – the participant was required to adopt and respond in their cast roles. It was anticipated that participants would be likely to hold onto proposed strategies and apply them consistently when adopting either role. On the other hand, participants may have tried to overcompensate and deliberately tried to suggest new ideas in each role scenario to avoid being repetitive.

As discussed above, many of the product lifespan proposals involves a variety of PSS solutions. Such strategies were proposed across a range of reference products, with little discrimination between electrical and non-electrical products.

Despite little evidence of correlation between proposed actions of the assumed roles (consumer and designer) the proposition that consumers (users) can play a role in mitigating obsolescence is clearly evident. This aspect is worthy of further exploration. An emerging body of literature suggests that such practices offer potential in transforming design practices. The user can become a co-designer of a product as its travels through its lifespan, as the product can be adjusted, reconfigured and evolved to meet the different circumstances, changing needs and aspirations of its user.

A concept that combines elements of both PSS and user participation is the idea of a 3D printer to make new parts. Currently known as rapid prototyping, 3D printers are increasingly becoming more flexible, affordable and easier to use, finding new audiences beyond product-development professionals. As with previous printing technologies, such as the migration of laser and inkjet printers from professional office environments to the home, the adoption of low-cost desktop 3D printers could transform and blur the distinctions between the role of professional designer and that of the consumer. In such a context, the consumer participates in the actual design, customisation and ongoing maintenance of the product. This creates a new and fluid relationship between producer and users. This theme of collaborative design practices is significant and is discussed further in Chapter 9.

This project demonstrates there are many possible product lifespan responses that can be generated by both designers and consumers. Some responses are modest and conservative – such as giving away to friends and family, or donation – while others are more radical and speculative, including the rebuilding of new parts on a 3D printer or a PSS based around reconfiguring products and reuse. Many proposed strategies also illustrate the difficulty in determining 'what seems right' or logical for any one type of product. The pathway for prolonging the lifespans of any one particular products is often ambiguous, as no established method exists. Rather than struggling with these ambiguities, participants relied on creative interpretations to extend product lifespans and establish a new landscape of possibilities. This project demonstrates that consumers can and do determine the destiny of products. Consumers are equals in determining the possibilities for prolonging product lifespans.

7_ Applying strategies

Selected from prolonging lifespans examples discussed in Chapter 4 and findings from the Using and Consuming research event discussed in Chapter 6, three lifespan strategies have been identified and selected to be applied to the product design projects. The three strategies - Piggybacking, Reassignment and Scripting - have been chosen because they represent and illustrate a range of qualities that address product obsolescence. They are by no means definitive or optimal for all types of consumer electronic products. Any number of the other surveyed product, behavioural and societal examples could have been investigated further.

However, Piggybacking, Reassignment and Scripting have been assessed as suitable candidates against to the following criteria:
> Each strategy is representative of a range of issues discussed within this research.
> Each strategy is relatively novel. Few, if any, product examples exist that embody each particular strategy.
> Each strategy is relatively unexplored in its potential as a means of mitigating product obsolescence.

7.1 Identified strategies

Piggybacking

Technological change is identified as a major cause of obsolescence in consumer electronics. [Refer to Chapter 2] The term Piggybacking, devised by the author, is a strategy that can address technological obsolescence. It is defined as being able to renew and enhance functionality in a technologically obsolete product through the addition or adding-on of a secondary device or component. A more detailed account of Piggybacking including identified examples of the strategy is discussed in Section 4.2.4.

Reassignment

The term Reassignment, also devised by the author, is an evolution from the informal strategy of repurposing. Repurposing refers to when an obsolete product is adapted for a different or entirely new purpose. Such activities are mostly informal user-oriented ones, as illustrated by the examples presented in Chapter 4. [Refer to Section 4.3.1 for a discussion on repurposing] This includes activities such as product hacking (Make 2009), developing-world necessity (Pentagram 2003) and tinkering (Thomson 2008).

However, the strategy of Reassignment (devised for this research) proposes a structured and formalised design response to transform a product's function into something entirely new. Thus Reassignment is defined in this research as: a product can be reassigned to perform entirely new functions through a formalised and structured design process involving software and/or hardware reconfigurations. As with repurposing, these transformations may not be anticipated by the original design team or manufacturer, but could be developed by others. Not to be confused with upgrading, Reassignment is not an upgrading strategy of functionality, but offers entirely new product functionality.

Reassignment repositions informal user-centred design practices to a formalised design and product development orientated activity. [Refer to Figure 42] As a process, the terms can be used interchangeably. However, for the purposes of this research, the term 'Reassignment' is preferred as it denotes activity as a formalised strategy and not as a make-do or tinkering activity.

Repurposing	User-centred (informal) design practice
Reassignment	Formalised and structured design process

Figure 42: Defining Repurposing and Reassignment

Scripting

The third strategy to be applied to design projects within this research is the relatively unexplored strategy of Scripting. Scripting can be defined as guiding user behaviour through product design, such that the user behaves in a 'scripted' manner (Jelsma and Knot 2002). A more detailed account of the strategy is offered in Section 4.2.3. Implicit within the notion of Scripting is unpicking and defining the roles of designer and user. Within any design project, a 'geography of responsibilities' (Akrich 1992) is negotiated.

Design decisions are made on delegating to what extend users will play in interacting with the product. With regard to consumer electronics, scripts within many of these products are to prevent, not prolong, product life. Security fasteners, warning labels stating 'void warranty if removed' or 'no serviceable parts inside', sealed housings and surfaces that scratch easily and show signs of unacceptable wear send strong signals to the user of looming obsolescence. If turned around, scripts within products could offer a powerful way of engaging the user in prolonging of a product's lifespan.

These three strategies have been chosen because they offer potential when applied to design projects as catalysts for new product innovation. Each of the three strategies is applied to the design projects, including a pilot design project undertaken by Year 2 product-design students [Refer to Section 7.2] and three design projects undertaken by the author. [Refer to Chapter 8]

7.2_Pilot design project: Piggybacking, Reassignment and Scripting

Figure 43: Pilot design project with design students [photo: author]

This pilot project offered the opportunity to trial the use of Piggybacking, Reassignment and Scripting strategies applied to a structured design projects. The project seeks to address research question Q4, *Can product lifespan strategies be successfully applied to design projects?*

In order to answer this question two supplementary questions are posed:

1. *Can proto-professional designers successfully apply specific product lifespan strategies to design projects?*
2. *What can be leant from applying specific strategies within the design process?*

Year Two product-design students from The University for the Creative Arts, Farnham, UK, participated in a the project that took place over a four-week period in May 2007. [Refer to Figure 43] Co-ordinated by the author, students attended formal studio and tutorial sessions for one day a week during this period. Time was allocated for independent study to work on developing design proposals.

Participating students had previous introductory knowledge on principles, tools and strategies for designing for sustainability. This included introductory knowledge on product lifespan strategies, such as upgrading, modularisation and product service systems (PSS). Supplementary readings and reference materials on the topic were also made available through the course website. Students were made aware of their contribution towards this research.

7.2.1_Project summary

Students were briefed to choose one of three consumer electronic products. Each product type was assigned to a specific product life-span strategy; Piggybacking, Reassignment or Scripting. [Refer to Figure 44] They were required to apply the prescribed strategy to the chosen product. The project followed a typical design process as described in Section 5.3.1, a process familiar to the students.

Strategy	Product type
Piggybacking	Analogue to DAB radio (car or home)
Product Reassignment	Mobile phone to new device
Scripting	AA Batteries - Disposal & Reusable

Figure 44: Product life-span strategy and Product type pairing

Sample products were supplied for analysis, testing and mock up. Upon completion students were required to produce an accurate 3D CAD or physical model as well as a presentation board to communicate their design proposals. A summary of the event is shown below in Figure 45.

Activity	Addressed Questions
Student design project using one of three strategies; Piggybacking, Reassignment and Scripting Each strategy to be applied to a specific product Simulation of a professional design process	Can proto-professional designers successfully apply product lifespan strategies to design projects? What can be leant from applying strategies within the design process?

Figure 45: Summary of design activity

7.2.2_Findings

Can proto-professional designers successfully apply product lifespan strategies to design projects?

All students who undertook the project demonstrated an understanding of their chosen product lifespan strategy and why its application would be beneficial to the assigned product type. Despite this understanding, the design outcomes from the project were of a varying success. The most successful project outcomes resulted from Reassignment. Two of the four students who undertook this strategy produced novel solutions that offered new functionality into obsolete mobile handsets. One design in particular sought to reassign a mobile handset as an alcohol breathalyser. [Refer to Figure 46] A similar concept is explored further in the author's own design projects. [Refer to Chapter 8]

Figure 46: William – add-on module to convert a mobile phone into a breathalyser

Only one student project addressed the strategy of Piggybacking. In this instance, the student explored design solutions to piggyback and combine a car-based DAB radio module with a car cassette player. [Refer to Figure 47]

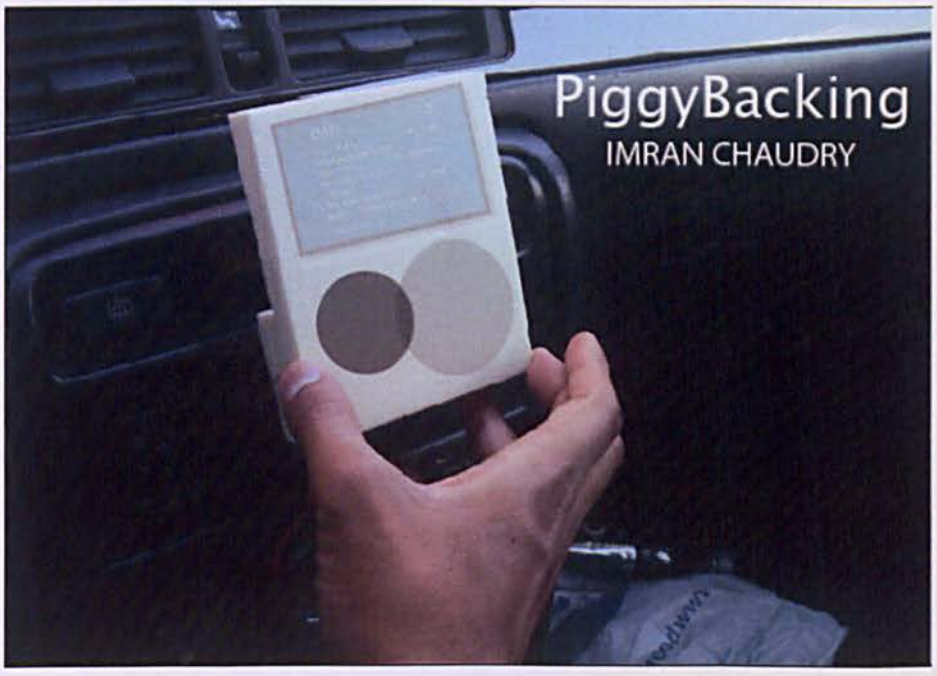

Figure 47: Imran – an addon DAB radio module for a car radio/cassette player.

The least successful of the student projects concerned Scripting. Two students struggled with expressing design scripts, especially when partnered with disposable and reusable batteries. The design of scripts involves combining product semantics, user psychology, product form and graphics. However, the projects lacked resolution. In both instances, it was hard to comprehend how the product could guide user behaviour.

What can be leant from applying strategies within the design process?

Piggybacking and Reassignment were the most successful projects in terms of produced outcomes. This pilot project suggests these two strategies can be successfully applied to design projects. The outcomes from the Scripting projects were more problematic because of the lack of clarity in the design proposals. This may have been because of the struggle students found in dealing with the many intangible aspects of Scripting that needed consideration. The choice of product type may have also compounded the challenge the students faced in applying the strategy. On the other hand, Piggybacking and Reassignment strategies are more easily defined especially in terms of technical parameters as reflected by the project outcomes. A selection of project outcomes is presented below in Figure 48.

Reassignment: Mobile Phone

Adam – 2ndage Nokia phone. "Reuse your old mobile phone by handing them (sic) to the next generation. New firmware enables your child to use your old mobile (phone) responsibly in a controlled way set by you".

Reassignment: Mobile Phone

Dan – "Based around a specific phone, the Nokia 6630, the external housing is replaced with a housing that enables the phone to stand on end. The proposed reuse is as an electronic cookbook offering audio prompt whilst following a recipe".

Reassignment: Mobile Phone

Peter – "The phone is reassigned as a testing multi-meter device through the addition of an add-on cradle with probes."

Scripting: AA Batteries - Disposal & Reusable

Alana – "Development of graphics, icons to communicate battery end-of-life behaviour – dispose of responsibly or recharge reusable batteries".

Scripting: AA Batteries - Disposal & Reusable

Don – "a combined PSS system that uses RFID chips built into each battery and web based tracking system that rewards consumers with battery credits if they recycle their dead batteries".

Figure 48: Selected student design proposals

7.2.3_Evaluation: Pilot project

Students demonstrated a good understanding and reasonable application of Piggybacking and Reassignment, but were less successful in interpreting and applying Scripting[23]. As a result, the design outcomes for all three strategies were quite varied. Those in the Scripting project found it very challenging and struggled to find an optimum approach to embed scripts within their design.

Many students also struggled with balancing the technical issues with context of use. In some cases, quite complex PSS solutions underpinned their proposals, but in most cases these were not resolved or clearly communicated. For instance, Adam and Don discussed aspects of service design as a part of their presentation. Although less successful in the final design outcome, it suggests some students were aware of positioning their design solutions within a business context or the consumer experience. There was a genuine effort to reconcile the complexities and challenges of designing for product lifespans within these contexts. The emphasis on PSS-type solutions does correlate with the design proposals from the Using and Consuming research project. [Refer to Chapter 6] In both studies PSS solutions featured.

The small sample of students undertaking the pilot study was a limiting factor. Only one student chose the Piggybacking project and only two chose the Scripting project. The most successful project was the Reassignment of mobile phones. Four students undertook this project, resulting in a greater diversity of design solutions and more innovative and resolved design solutions. In many cases, students proposed solutions that went beyond the physical object. For instance, the Reassignment projects relied on a combination of software and hardware augmentations to the core phone unit, while the other projects combined elements of service systems and business innovation.

In conclusion, this project demonstrates that lifespan strategies, notably Piggybacking and Reassignment, can be successfully applied to design projects. This pilot project offers a confirmation of the chosen design research method in framing valid responses to the research question Q4. *Can product lifespan strategies be successfully applied to design projects?* [Refer to Figure 1]

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[23] Without explicit direction and tutorial support, undertaken the by author, it is unlikely that the students would have been able to so successfully capture the essence of the strategies within their respective design projects.

8_Applying strategies: design projects

This third research project is the largest component of applied research undertaken as a part of this doctoral research. It entails the application of Piggybacking, Reassignment and Scripting strategies to three individual design projects. These design projects seek to answer a key research question:

Q4. Can product lifespan strategies be successfully applied to design projects?

[Refer to Section 5.4.3 and Figure 1]

In addition, each project is independently evaluated to a set of supplementary questions. [Refer to 8.1.8]

This chapter discusses the specifics of each project. Each is documented in the following three sections, as indicated in Figure 50. A summary and context for each strategy is introduced at the start of each section, while further reference to each strategy can be found in Chapter 4 and a rationale for their selection is offered in Chapter 7. Each project follows a defined design process as discussed in Chapter 5. The table below [Refer to Figure 49] indicates the lifespan strategy linked to each design project.

Strategy	Product
Piggybacking	DAB radio
Reassignment	Breathalyser
Scripting	Laptop computer

Figure 49: Life-span strategy and design project

The table below summarises the design documentation contained in this report for each project.

Project	Section	Design documentation
Section 8.1	Piggybacking-DAB radio	Concept design sketches Test rig Foam models Orthographic illustrations Technical drawings – General Assembly Appearance model Evaluation
Section 8.2	Reassignment – Mobile phone Breathalyser	Concept design sketches Foam models Orthographic illustrations Technical drawings – General Assembly Appearance model Evaluation
Section 8.3	Scripting – Laptop computer	Concept design sketches Orthographic illustrations Technical drawings – General Assembly Evaluation

Figure 50: Project documentation

8.1_Design projects: Piggybacking

This section documents the application of Piggybacking to a design project. Piggybacking is applied to the design of a DAB (Digital Audio Broadcasting) radio enhancement for existing AM/FM household radios. Through the addition of a piggybacked component, the lifespan of an existing AM/FM radio can attain renewed digital audio functionality. [Refer to Section 4.2.4 and Section 7.1 for a definition and further discussion of Piggybacking]

8.1.1_ DAB: Digital Audio Broadcasting

The migration from analogue to digital radio and television services has been widely accepted by UK consumers and accelerated by the UK Government's policy to complete the digital switchover by 2012 (MTP 2008). Fears that the digital switchover would increase, beyond normal growth, the disposal rates of obsolete televisions and ancillary equipment has not occurred (Armishaw et al. 2007). This could be partially attributed to the adoption of digital set-top box receivers. Set-top boxes are an example of a piggyback solution, as they reduce the need to replace non-digital equipment by extending their functional lifespan into a digital age.

Alongside the rapid rollout of digital television services, DAB (Digital Audio Broadcasting) could increase product obsolescence as well or offer opportunities for new innovations to prolong product lifespans. The growing popularity of DAB digital radio potentially threatens the lifespan of existing analogue equipment. In the first quarter of 2006 alone, 3 million DAB digital radio sets were sold in the UK (OFCOM 2006). However, the destiny for existing analogue radio and audio equipment does not necessary mean obsolescence. The functionality of analogue equipment, populating our homes and cars, could be extended through a Piggybacking approach. A DAB module could be attached to the analogue radio enabling it to receive digital services. Revo, a UK manufacturer of DAB radios, markets a solution that enables DAB radio services to be accessed in conjunction with existing car audio systems. However, Revo's system requires a specialist installer to undertake the conversion (Revo 2007).

8.1.2_Design project – Piggybacking DAB

The design brief devised for this project considers ways to migrate new digital radio broadcasting reception technologies onto existing household analogue AM/FM radio equipment. By doing so, the lifespan of existing radio equipment can be prolonged. The older (obsolete) technology is complemented through the addition of a new piggybacked technology to facilitate the reception of digital broadcasting services.

Piggybacking differs from upgrading in that it involves the addition of a supplementary devise to the original product. However, like upgrading, Piggybacking may be an attractive strategy for consumer electronic products that are prone to technological obsolescence. It offers a means of balancing out fast- and slow-changing technologies found in many consumer electronic products (van Ness 2003). The migration to digital TV and radio broadcasting taking place in many countries offers an opportunity for a Piggybacking approach to extend the lifespan of sunset[24] technologies. Despite the threat of widespread obsolescence the functionality of many existing analogue radios could be extended through Piggybacking. A DAB module could be designed to piggyback onto an existing analogue radio to enable the reception of digital broadcasts.

8.1.3_Rationale and design brief

The aim of this design practice-based research project is to demonstrate the application of the Piggybacking strategy through a practical design project. For the purposes of this project, the design process ends at the design documentation stage of the process[25]. Each stage has been documented through design drawings, schematic diagrams, computer models, CAD drawings, test rigs, components analysis and physical models.

Design Brief

The design brief for this project is stated as follows:

Devise a design solution to enable a range of existing household radios to receive DAB services. The design solution should extend the functionality of the existing radio equipment through the adoption of a Piggybacking strategy.

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[24] 'Sunset' is a term used at the Sony Design Centre to describe the phase of product's evolution when its technology ages and nears obsolescence (Kunkel 1999:27)

[25] Implementation, referring to the tooling, production and market launch of a design is beyond the scope and purpose of this project.

Design Criteria

> No specialist knowledge or tools required for installation

> To be adaptable to a wide range of household radios

> Avoid the use of special plugs and adaptors specific to certain makes and models of radios

> Compact and unobtrusive form-factor to fit with existing equipment

> Aesthetic resolution suitable for an item of precision audio equipment, context and environment of use

> Should be intuitive to install and use

> To consider economical production, quality of finish and materials, ease of maintenance

> Design for long service life and end-of-life disassembly

8.1.4_ Concept exploration

The design of household radios varies enormously presents significant technical challenges for a Piggybacking approach. Concept designs were produced exploring possibilities that would suit a wide range of radios, as typical encountered in households. A selection of generic household radio typologies where chosen on which to base a piggyback solution. They range from relatively large radio-cassette 'ghetto blaster' configurations, to smaller more compact 'kitchen' uprights. The age of radios considered in this study vary from the early 1980s to more recently available models. Figure 51 illustrates a range of typical household radio types considered for this project.

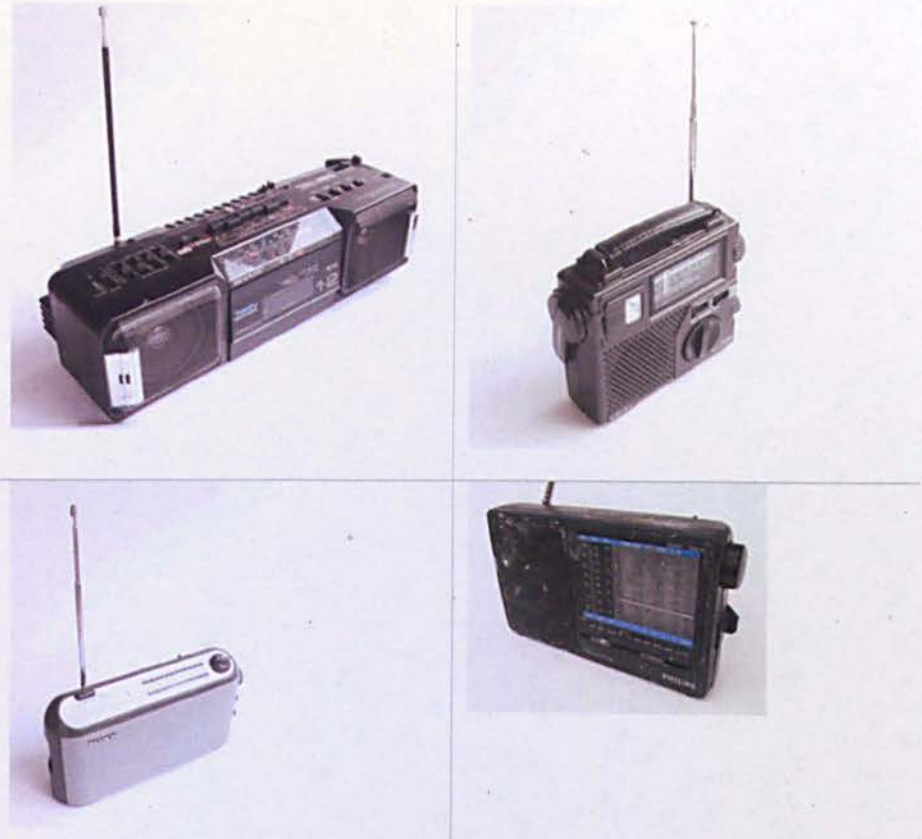


Figure 51: Typical household radio types [photo: author]

A feature analysis of the sample household radios found that the following elements are consistent on all considered radio types:

> On/off control

> Tuneable AM and FM radio reception

> Extendable aerial (two aerials on some types)

> AC/DC power (optional on some types)

> Headphone jack (3.5mm co-axial stereo)

> Integral speaker with volume control (optional tonal control on some types)

> Carry handle

Unlike individual component HiFi equipment, it was apparent from this investigation that few if any of the identified radios had provision for an external audio input. On component HiFi equipment this is often standardised through the use of RCA connector cables. One consistent way of introducing an external signal into the sampled radios is through the use of a radio frequency (RF) modulator. An RF

modulator takes an audio or video signal from a device and turns it into a FM[26] modulated radio frequency signal. Such devises are common on VCR's and older-style video TV game consoles. The radio can be tuned to a predetermined frequency on the FM band to receive the RF signal via a FM modulator.

The schematic diagram below describes the configuration DAB/FM modulator used in this project. An innovative feature of this configuration is the use of the existing radio's aerial for both receiving the DAB signal and the 're-broadcasting' (in this case as FM modulated) signal. An added benefit from this arrangement is that other radios in the local vicinity (up to 25 metres) may also be tuned to receive the re-broadcast signal. Signal strength will vary depending on radio reception sensitivity and physical obstructions, such as masonry or thick walls. Functionality is further enhanced through the adoption of a infrared (IR) control enabling the use of a separate/ removable control panel to operate the device.

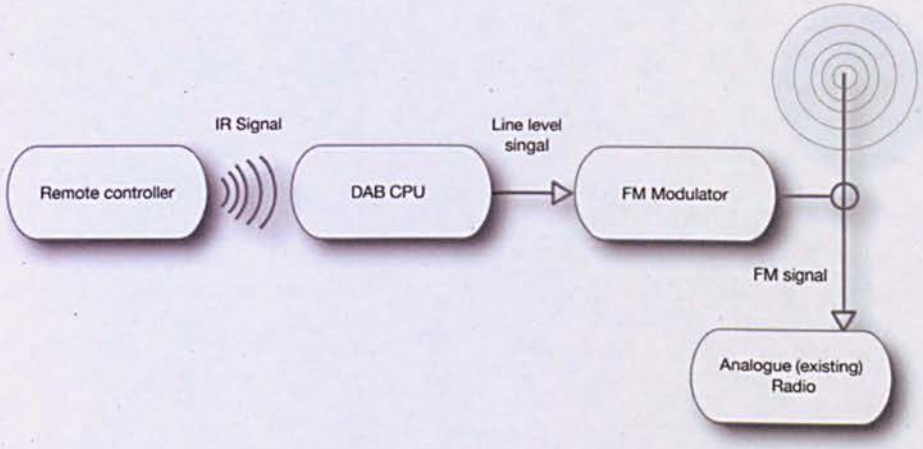


Figure 52: Schematic diagram of DAB modulator unit

A 'bread board' test rig was devised to test the concept of FM modulation of a DAB signal using the existing radio's aerial. The test rig enabled a 'proof of concept' of the FM modulation of a DAB signal. Figure 53 below illustrates and identifies the elements of the 'bread board' configuration.

[26] Frequency modulation (FM) and amplitude modulation (AM) are two common means of encoding information broadcast by radio waves

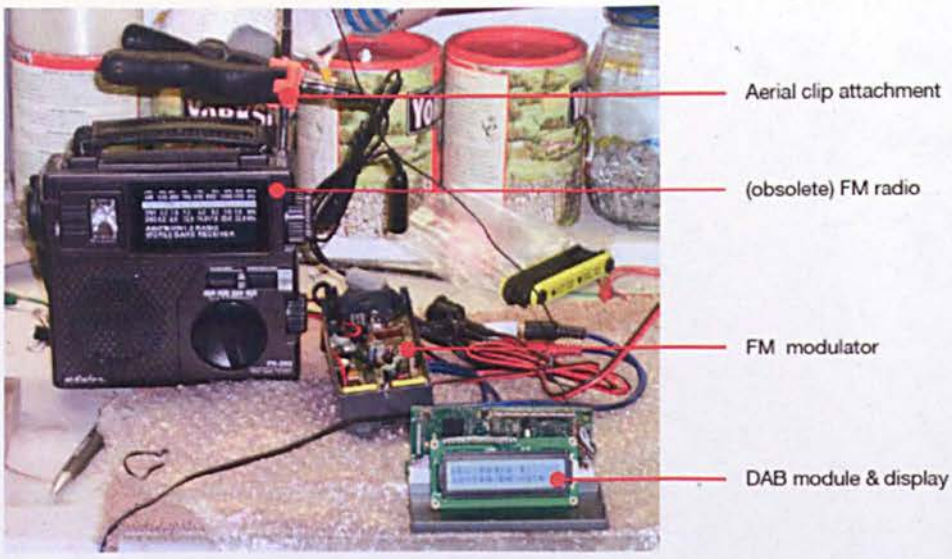
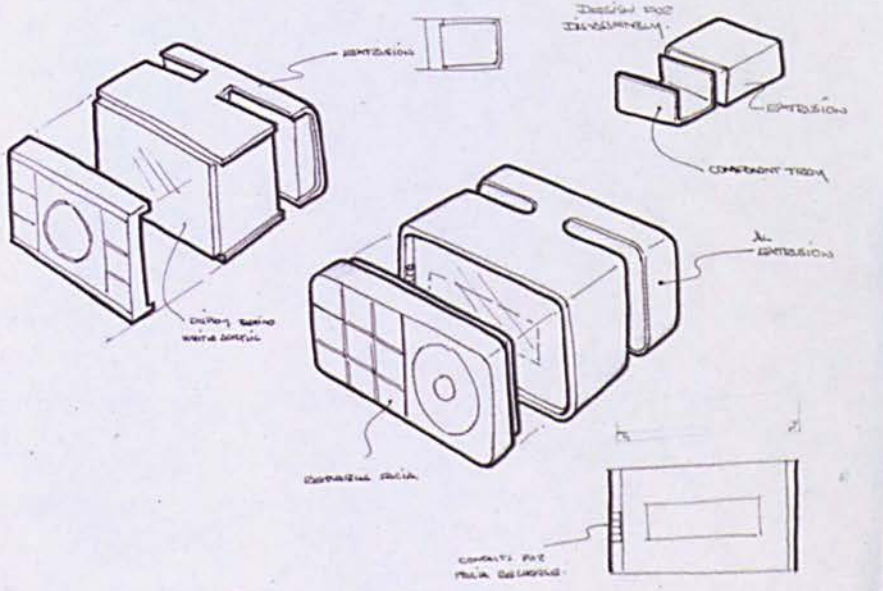


Figure 53: Proof of concept 'bread board' test rig [photo: author]

Figure 54 and 55 illustrates a selection of concept designs. A primary consideration at this stage was how the unit would piggyback on the range of sampled household radios. It was conceived at an early stage that the unit could be mounted directly onto the aerial. This would enable simple user installation as well as act as a convenient anchor point onto the existing radio. It was decided that the use of a clip with a lead arrangement, as used in the test rig [Refer to Figure 53] would not be an aesthetically or functionally elegant solution.



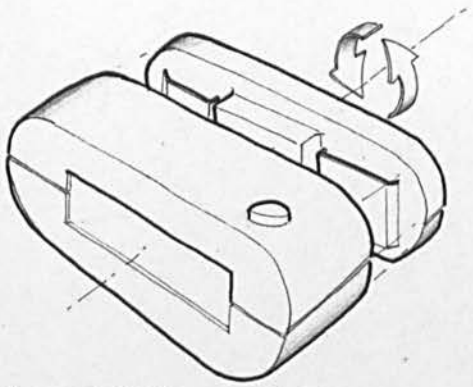


Figure 54: DAB Concept sketches

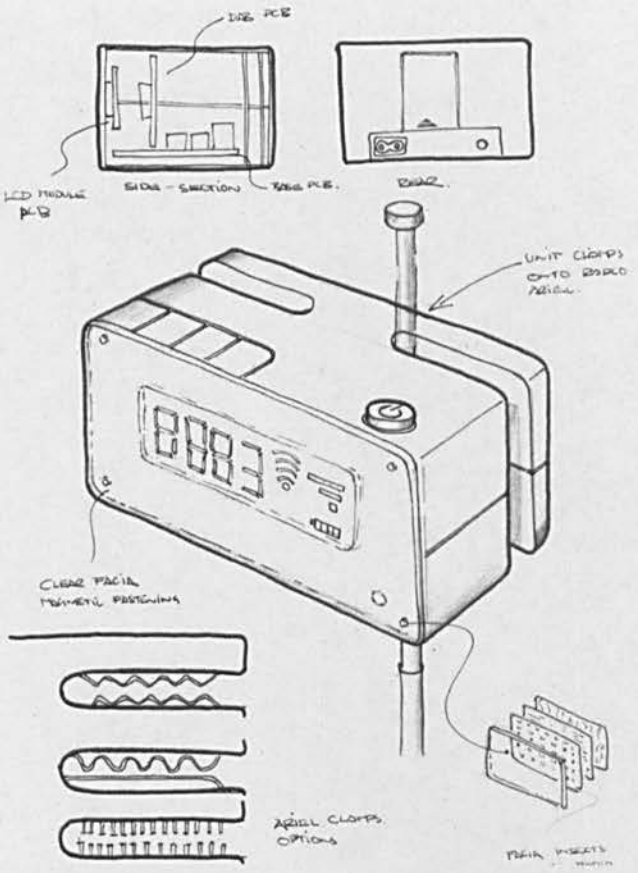


Figure 55: Concept sketches exploring aerial mounting options

Concepts were further explored as 3D volumes in foam. This enabled an assessment of human factors and form fit with existing radios. The preferred arrangement of mounting the DAB piggyback unit directly onto the aerial (of the existing radio) is shown in Figure 56.

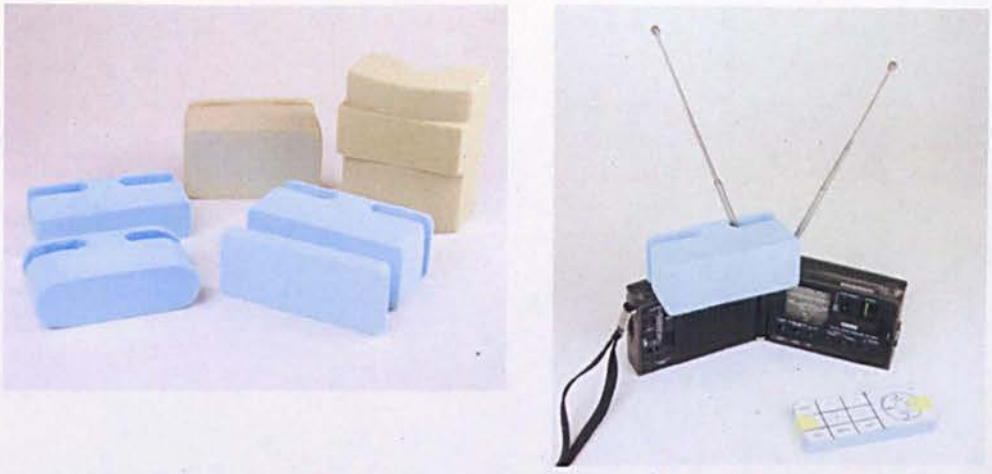


Figure 56: Foam sketch models – form exploration [photo: author]

8.1.5_Design Development

Figure 57: Form design development [photo: author]

From the field of possible concept designs, a preferred design was selected for development. The chosen concept design was determined to be the best match to the design brief criteria. Innovative features of this design include the direct aerial attachment of the unit and docking feature of the remote control which nests in the DAB unit when not in use. Each design feature is discussed below.

Aerial attachment

The unit attaches to the aerial of the existing household radio by means of sandwiching the aerial between a conductive serrated strip and foam pressure pad. The aerial enables the receipt and retransmission of FM radio frequency. Attachment points are offered on both side of the DAB unit to accommodate use with the widest range of radios. The serrated strip and foam pressure pad configuration was tested with a range of radios with varying aerials of varying diameters.

DAB base unit

The DAB base unit is the central processing unit (CPU) of the system. It receives it power from and external AC adapter that is plugged into the rear of the unit by means of a 3mm co-axial plug. Housed in the base unit are three discreet electronics subassemblies, the Digital to Analogue PCB[27], LCD[28] display and FM modulator that are collectively referred to as the DAB CPU. The base unit also contains ancillary items including an IR receiver for the remote control communications and a power management system for charging the remote control battery when docked.

Removable (remote) control panel

The control panel is removable from the base unit revealing a two-line screen display. It is held into position on the base unit by means of discreet magnets. When removed from the base unit the control panel functions as a remote control. Ergonomically, this is a much more desirable arrangement than trying to operate the control panel when mounted in-situ on the main DAB base unit on the radio. The removable control panel communicates to the DAB base unit via IR (Infra red) signal, in the same way a TV remote control does. The control panel contains an internal rechargeable battery that is recharged each time it is docked to the base unit. The control panel can also be operated without removal from the main unit. However, the display panel would not be visible, and would therefore be ergonomically undesirable. The remote control is designed to sit flat on a surface near the radio. It would operate up 5 meters from the base unit. Figure 58 illustrates the features of this design.

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[27] Printed circuit board

[28] Liquid crystal display

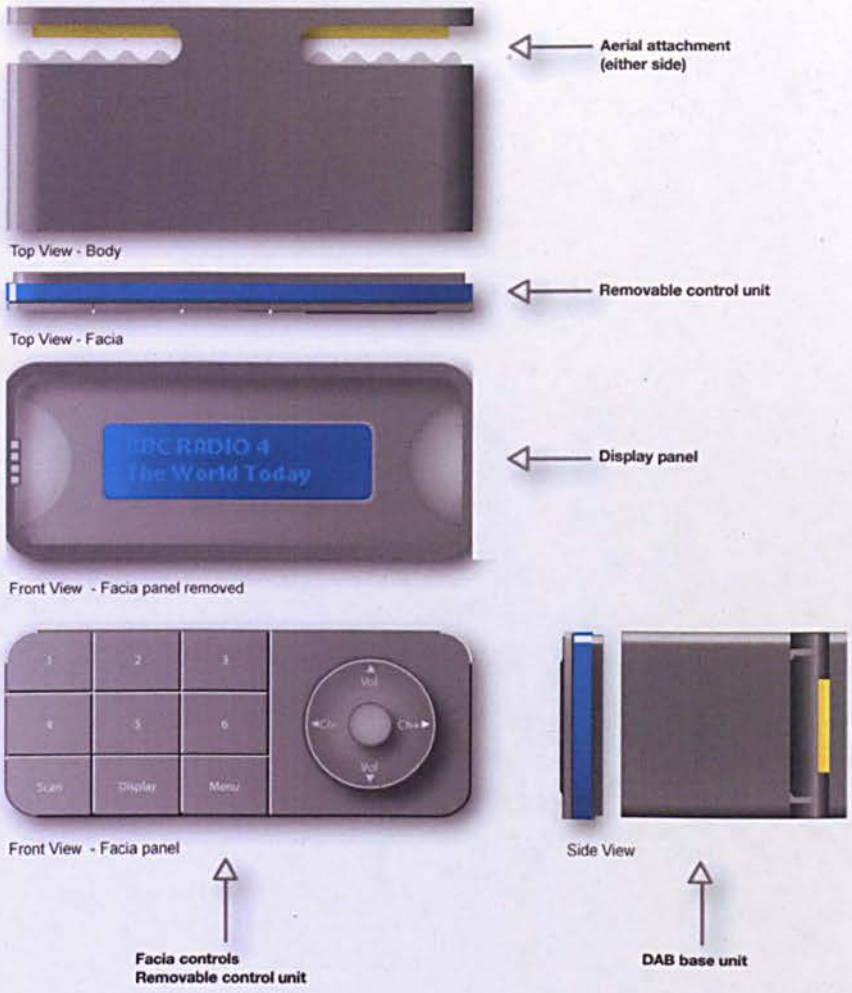


Figure 58: Preferred concept design

8.1.6_Documentation

A 2D CAD General Assembly drawing was produced [Refer to Figure 59] to resolve the following considerations:

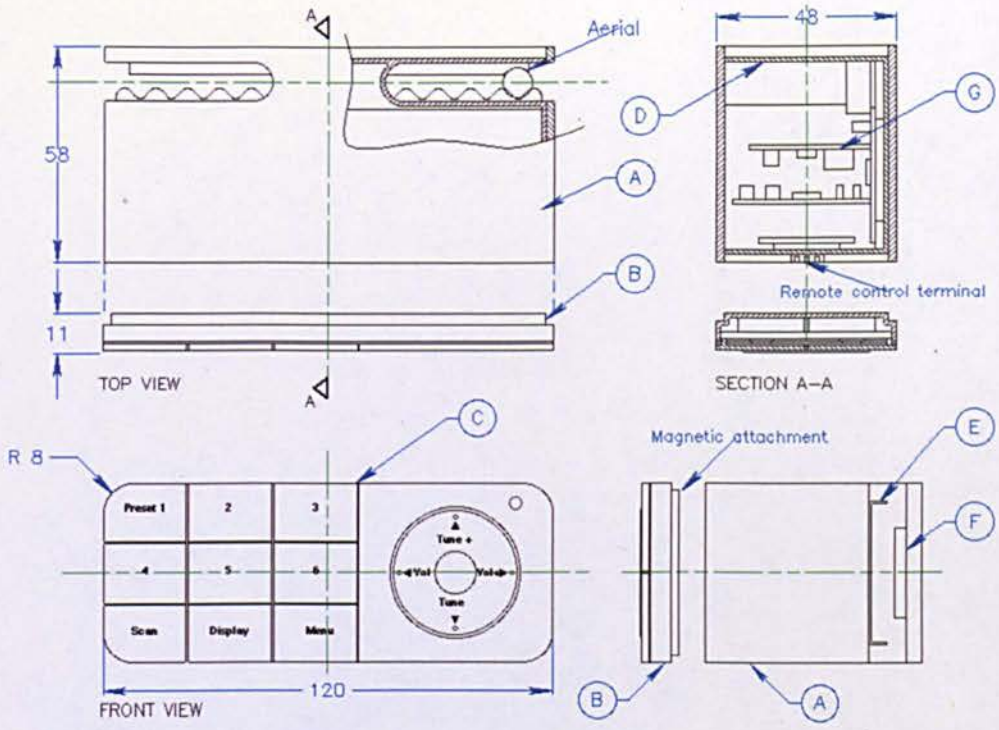
> Internal configuration and arrangement of components

> Housing material and design detailing

> Housing construction and manufacturing

> Control and interface

> Form, volume and aesthetics



Part	Description	Comments
A	DAB housing	Anodised Aluminium extrusion
B	Remote control housing	ABS injection moulding
C	Remote control - Facia panel	ABS injection moulding
D	Internal component tray	ABS injection moulding
E	Serrated conductive strip	Zinc plated steel
F	Foam pressure pad	EVA foam
G	PCB's and LCD unit	Edge connection mounting

Figure 59: General Assembly and major components (not to scale)

An appearance model was produced completing the design documentation for this project. [Refer to Figures 60 and 61]

8.1.7_Design statement: DABlife:

DABlife offers a way of prolonging the lifespan of existing analogue radios into the digital broadcasting age. As with any step change in technology, the progressive rollout of DAB services will ultimately affect millions of household radios as they progressively become obsolete. DABlife is a digital audio receiver that works in conjunction with almost any AM/FM radio. It enables existing radio equipment to receive Digital Audio Broadcasting (DAB) services. The unit attaches (piggybacks) onto an existing radio by attaching to the aerial. DABlife receives digital audio broadcast signals and rebroadcast them as an FM signal received by the existing radio. [Refer to Figures 60 and 61] The unit features a removable remote control panel that reveals a LCD display. Other household radios within about a 30 metres radius can also be tuned into the FM frequency to receive the digital broadcast.

Figure 60: DABlife DAB radio module [photo: author]

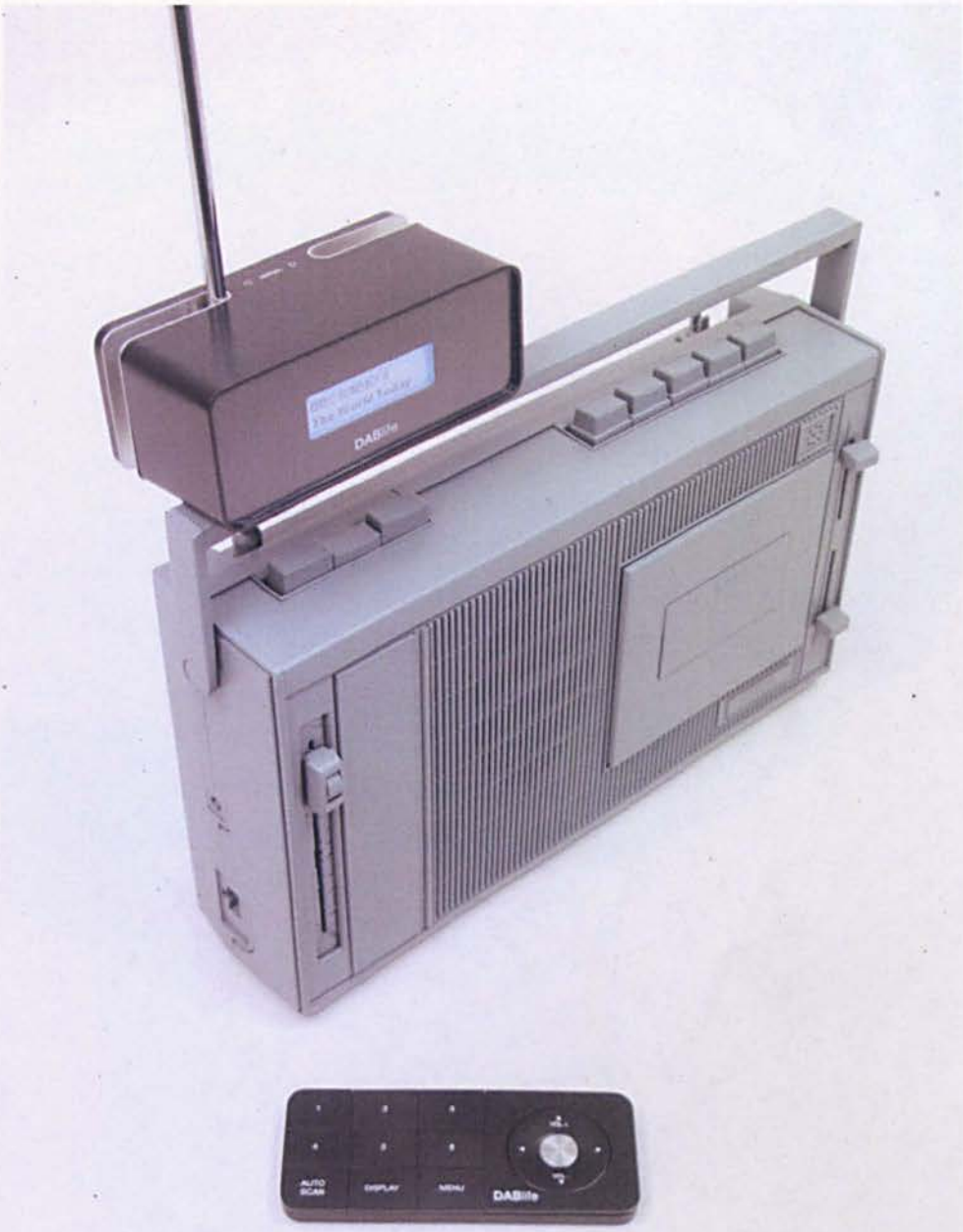


Figure 61: DABlife Piggybacked DAB module [photo: author]

8.1.8_ Evaluation Process

Design documentation for this project (DABlife), and subsequent design projects devised by the author (Psst! and LaptopLife) [Refer to Section 8.2.7 and Section 8.3.6], were presented to three experts for evaluation. The evaluators were chosen to represent a spectrum of knowledge covering important product development fields relevant to this research. These fields include environmental management of design, product policy and lifecycle product stewardship, sustainable product design and business innovation, commercialism and intellectual property.

Industry expert 1 is a Senior Sustainability Associate with a large international environmental consultancy. He consultants with industry and government on matters as diverse as commercial furniture, consumer electronics, office machinery, textiles and flooring. His particular specialist field is Product Stewardship, developing take-back schemes for end-of-life consumer electronics.

Expert 2 is an Environmental Manager for a New Zealand based commercial furniture company. Prior to his current role, he commenced his professional career as an industrial designer in the UK before becoming an environmental specialist for one of the worlds largest manufactures of telecommunications consumer products.

The third industry expert is a Materials Scientist with a degree in Materials Science and Engineering and a Doctorate in the field of advanced electronic ceramics. His current specialisation is innovation and commercialisation, in both industry and academic environments.

The evaluation process started with an invitation for the evaluators to respond to a set of four supplementary questions[29].

1. *Do you believe that this project successfully demonstrates the application of the proposed strategy of Piggybacking/ Reassignment / Scripting?*
2. *Can you think of other products that can benefit from this strategy?*
3. *Can you suggest improvements, shortcomings, oversights or other things to consider?*
4. *Which project do you think is the most successful and has the most potential in prolonging the life-span of consumer electronic products?*

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[29] These questions were also applied to Reassignment and Scripting project evaluations. These questions complement and assist in addressing the key research question in this study. [Refer to the beginning of Chapter 8 and Figure 1]

8.1.9_ Evaluation: Piggybacking

DABlife aims to extend the lifespan of existing radios by delaying or slowing technological obsolescence. One evaluator said that Piggybacking "*represents a sophisticated view of defining 'durability' and product life extension*". A Piggybacking strategy offers a transitional solution to obsolescence by bridging step changes in technology – for example, the switch from analogue broadcasting to digital broadcasting technologies. With this in mind, other opportunities exist in the consumer electronics sectors to apply a Piggybacking strategy. *"Rapid technological and software-based changes and cycles would be the most obvious beneficiaries e.g. the transition from analogue to digital".*

DABlife was noted as being an analogous solution to set-top digital TV boxes. The success in the marketplace of these devices as a transitional solution spanning between analogue and digital broadcasting technologies was noted. As was noted, the potential of DABlife as a marketable product: "*worthy of exploring IP issues for commercialisation*" and "*would be seen as desirable and acceptable by many in the market*".

Evaluators outlined no particular shortcoming of the project. However, there was some discussion of aesthetic appeal and appropriateness for intended markets. Would the product need to fit into an aesthetic appropriate for retailers such as *Argos* and *Dixons* at the 'value' end, or take a *Bose* or *B&O* high-end audio products approach? [For an evaluation notes of the three Design projects refer to Appendix 8]

In conclusion, the evaluators agreed that the project successfully demonstrates the applied strategy of Piggybacking and support findings in response to the research question 4. [Refer to Chapter 8]

8.2_Design projects: Reassignment

This second design project entails the application of the Reassignment strategy. Reassignment refers to when a product is adapted for use in a different or entirely new purpose through a structured and formalised design response. This project considers ways of transforming or reassigning a mobile electronics device from its original purpose into performing new functions. In this instance, the chosen reference product is a mobile phone. Because of the huge number of mobile phones in circulation and their notoriously short lifespans (Gartner 2008; Canning 2006), they present as an ideal candidate for investigating the application of a lifespan strategy.

8.2.1_ Mobile electronic devices

Whilst this project is non-specific about the actual type or model of phone utilised for a Reassignment strategy, the project is generally based upon what referred to as 'smart phones'. These phones are becoming increasingly prevalent and they are programmable enabling functionality upgrades and enhancements. Many Smart phones combine the functionality of a typical mobile phone with limited mini PC or PDA capabilities. Although there is no precise definition of what a smart phone is (Best 2008) it is generally defined as a device that is programmable utilising a software operating system, such as; Symbian OS (now fully owned by Nokia), Java ME (originally developed by Sun Microsystems) or Windows Mobile (owned by Microsoft corporation). Through a combination of software and physical attributes Smart phones can be programmed to undertake enhanced functionality including; Digital photography, GPS navigation, data communications and games. Smart phones offer a flexible technology platform that is suitable for a Reassignment strategy.

Mobile phone
Nokia 6120

Mobile phone
Nokia 3310

MP3 player
Apple iPod

Figure 62: Candidates for Reassignment, mobile electronic devices

Notwithstanding the emphasis on smart phone technologies, this project also considers other mobile electronics devices that have a capacity for Reassignment. This includes older-generation mobile phones[30] such as the Nokia 310[31] and various Apple iPod models of which also offer an attractive technology platform for developing new device functionality. [Refer to Figure 62]

8.2.2_ Rationale and design brief

The design brief established for this project is to apply the strategy of Reassignment to a mobile phone or similar mobile electronic device. Proposed design solutions should seek to enable an obsolete device to be reassigned to new functional purpose, thereby prolonging its lifespan. Because of the limitations of reconfiguring many older-generation mobile phones, other mobile electronic devices should also be considered in demonstrating the application of Reassignment.

Design criteria

> To use the existing product

> Minimise or avoid specialist modifications to existing product

> Not require specialist installation

> Should be intuitive to install and use

> To consider the addition of supplementary user-installed subassemblies

> Compact and unobtrusive form-factor to fit with the portability of existing equipment

> Aesthetic resolution suitable for an item of precision ICT equipment, context and environment of use

> To consider economical production, quality of finish and materials, ease of maintenance

> Design for long service life

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[30] Older-generation mobile phones present a significant challenge for reassignment. They are highly specialised products engineered for a specific but limited functionality. Their flexibility is further limited through the use of software encryption, locking devices to specific service provider networks. In such instances the correct PUC (personal unblocking codes) codes and SIM (subscriber identity modules) cards are required to enable the use and reuse of the phone. If wrong codes are entered or not available, the phone may be rendered inoperable.

[31] The Nokia 3310 features the capacity for interchangeable customised covers to enable product appearance to be personalised.

8.2.3_ Concept exploration

A range of reassigned uses was explored through concepts sketches. Possible reconfigurations considered included an alcohol breathalyser, weather station (anemometer), electrical test multi-meter and solar clock. [Refer to Figure 63]

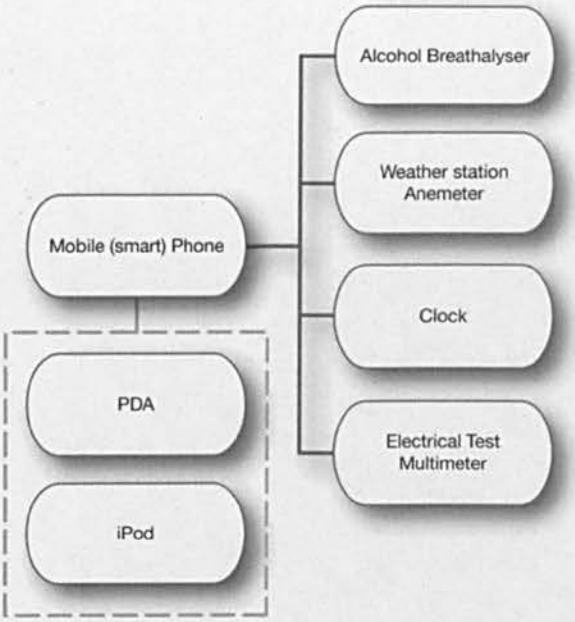

Figure 63: Schematic of Reassignment possibilities explored within this project

Each concept is based upon utilising the functional assets within the existing device. The functional assets are the component and sub-assemblies that perform specific tasks to enable to product to function. For example, mobile phones all have a battery that provides electrical power to the PCB (Printed Circuit Board) to enable the function of receiving and making phone calls. The same battery[32] can also provide power for an ancillary attachment that connects to the mobile phone via the terminals on the base. The table below summarises the assets typical found of a mobile phone and the generic utility they offer for a Reassignment strategy. [Refer to Figure 64]

[32] Of the assets within a mobile phone the battery has a pre-determined life-span based upon the number of charge and discharge cycles. Over time its performance diminishes.

Phone asset	Generic utility
Battery	DC Electrical power
PCB	CPU – device management Firmware - software upgrade RAM - reprogrammable memory
LCD display	Device feedback - screen interface
Keypad	Device control - keyed input
External connectors	External device connection
Speaker	Device feedback - Audio output
Microphone	Device control - Audio input

Figure 64: Mobile phone assets and functions

Each asset can be reconfigured through software and hardware modifications. It is the reconfiguration of these assets that is explored within each concept design. A selection of three (of the four) concept designs are presented and discussed below.

Concept 1_Mobile phone Reassignment - alcohol breathalyser

This concept exploits the portability of a mobile phone reassigned as a portable alcohol breathalyser. [Refer to Figure 65] This proposal requires the addition of a supplementary device to interface with the phone's CPU through attachment to the terminal ports located on the base of the phone. The added device draws power from the phone's battery to power-up its internal PCB and sensors. The device 'talks' to the mobile phone's CPU, reconfiguring its operating system by loading a Symbian- or Java-based 'breathalyser mode' applets[33]. In such a circumstance, programming would require 'smart' phone capabilities.

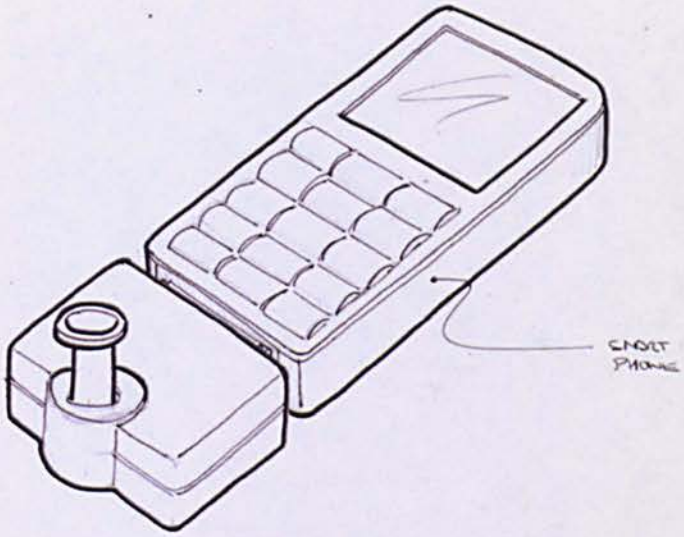

Figure 65: Concept design - mobile phone Reassignment - alcohol breathalyser

The personal alcohol breathalyser and mobile phone devices share many similarities in terms of components, construction and form. For instance, the FiT digital alcohol computer reveals an uncanny resemblance to a mobile phone. [Refer to Figure 66]

Figure 66: The FiT Digital alcohol computer

[33] An applet is a software component that runs within another software program.

Both products also share a similar context of use and compatibility. They are both portable electronic devices often used outside the home in the conjunction to arranging travel and meeting plans. In addition, both products contain many similar functional assets as shown in table below. [Refer to Figure 67]

Battery	External connectors
PCB	Speaker
LCD display	Clock
Keypad – alpha numeric	

Figure 67: Shared functional assets

Although the purpose of this concept is to extend the functional lifespan of an obsolete product, it is also conceivable that the availability of an 'add-on' alcohol breathalyser could be marketed as an accessory for non-obsolete devices. This approach is common with Apple iPods, where third-party vendors offer a range of accessories. This includes FM radios and transmitters, microphones and Bluetooth adaptors. For the purposes of illustrating the broader possibilities of this concept a drawing of an Apple iPod alcohol breathalyser was also produced. [Refer to Figure 68]

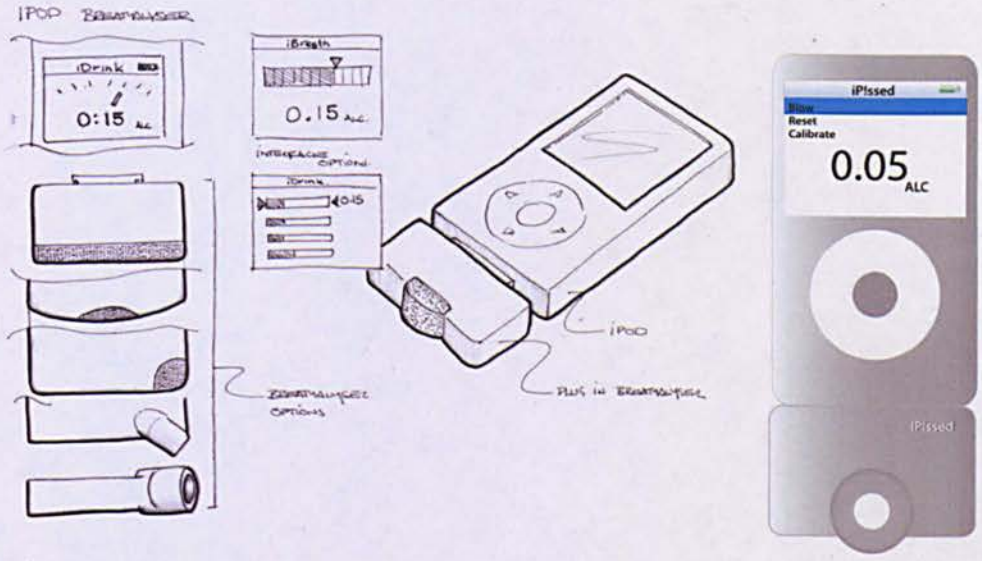

Figure 68: Concept proposal - iPod alcohol breathalyser

Concept 2_Mobile phone Reassignment - weather station (Anemometer)

An anemometer is a device for measuring wind velocity. It is a standard piece of equipment usually found in meteorological weather stations. However, beyond the specialist needs of meteorologists such devices, especially portable hand-held devices, are also popular with people engaged in various outdoor and sporting pursuits, such as sailors, hang-gliding pilots and archers. These activities depend on knowing wind velocity. Although many practitioners of these sports become highly skilled in reading approximate wind velocity without specialist instruments, accurate measurement can optimise performance and safety. For example, a crosswind will significantly influence an archer's ability to hit a target, or may help a hang-glider determine safety before launch. Ideally, an anemometer needs to be portable and readily accessible, much like a mobile phone. This concept combines an anemometer sensor with a phone. [Refer to Figure 69] As with previous concept, this proposal aims to extend the lifespan of the phone by offering new functionality.

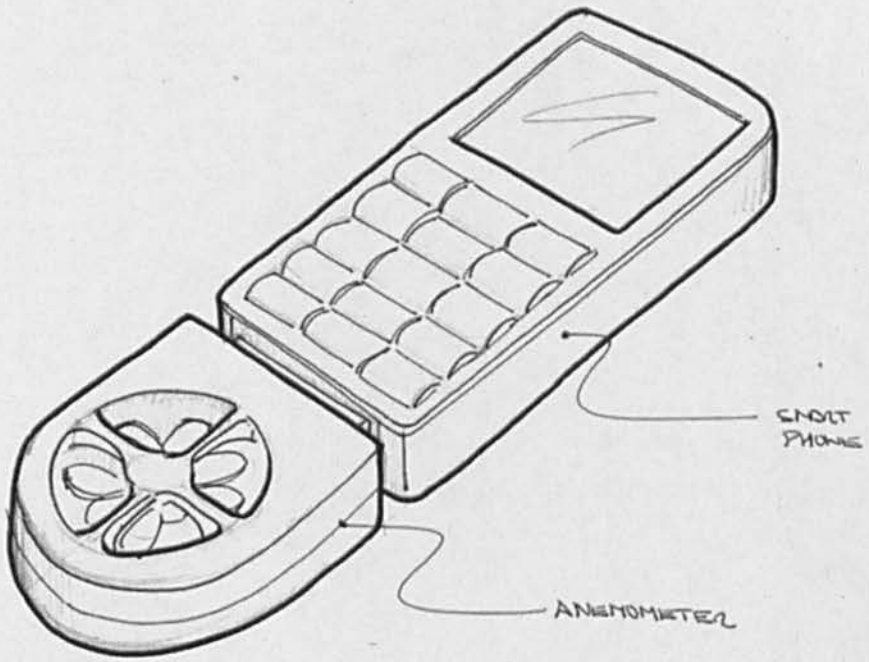

Figure 69: Concept sketches - mobile phone Reassignment - anemometer

Added functionality of temperature and humidity sensors could also be incorporated into the device without much cost or difficulty. In such a case, the anemometer would become a hand-held weather station combining wind velocity,

temperature and humidity, thereby widening its appeal to other users. The add-on anemometer uses many of the existing assets found in a mobile phone, including battery, screen and keypad. These provide power and become the interface for display information and keypad input.

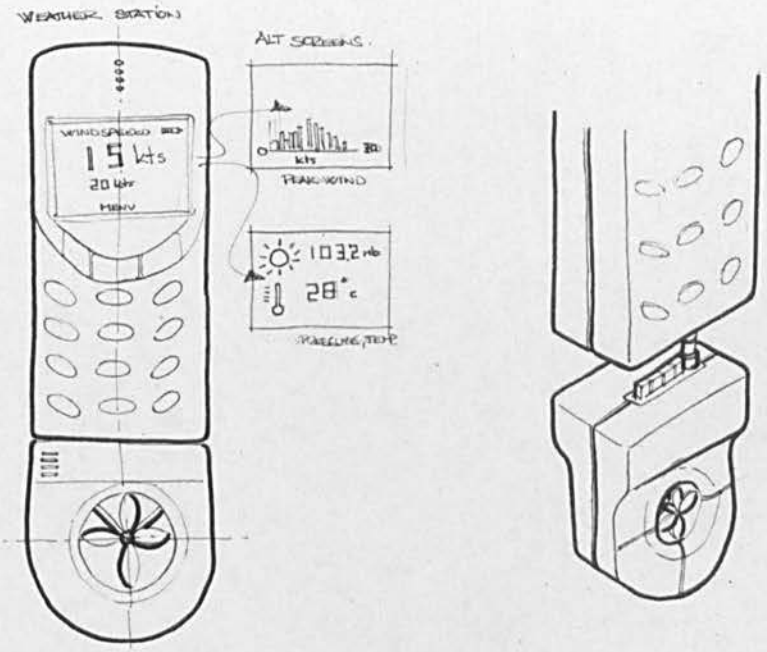

Figure 70: Concept sketches – interface and connection

Concept 3_Mobile phone Reassignment - solar clock

This concept uses existing functionality found in all mobile phones; all phones provide a clock function. The basis of this concept is a window-mounted cradle that charges the phone through the provision of a photovoltaic cell. Unlike the other Reassignment concepts, this proposal would be more applicable for older-generation mobile phones. In this concept, the phone docks plugging into a window-mounted tray. The mounting tray is held to the window by two suction cups with a photovoltaic cell facing outwards towards the glass. The tray provides trickle charging power to the phone's battery, thereby enabling it to provide a clock display for 24 hours a day. Essentially the concept is a window-mounted solar clock. [Refer to Figures 71 and 72]

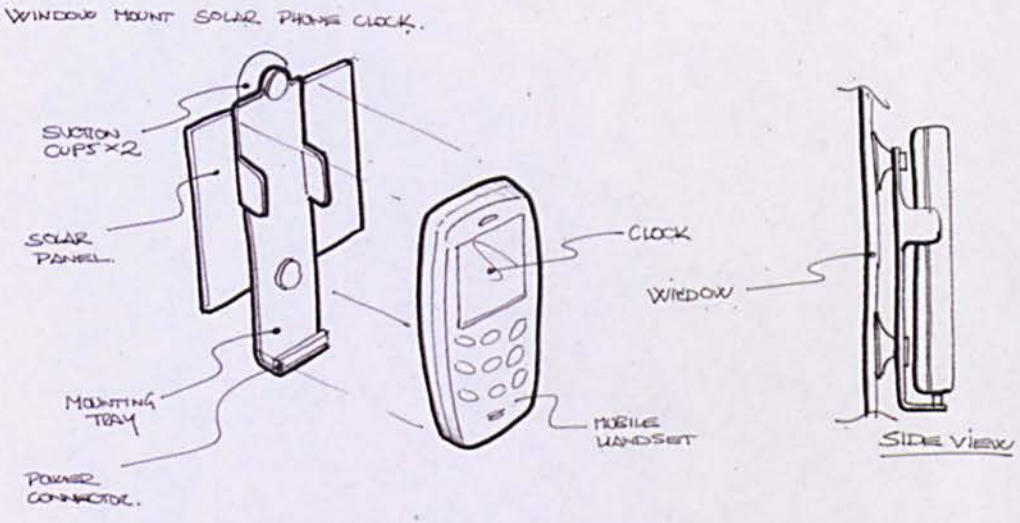

Figure 71: Concept sketches - mobile phone Reassignment - solar clock

Figure 72: Concept sketches - clock display

8.2.4_Design development

The alcohol breathalyser concept was chosen as it best demonstrates the strategy of Reassignment. A degree of compatibility exists between a mobile phone and an alcohol breathalyser. Both products complement each other in the way they are used - if for nothing more than being able to phone for a taxi if the user determines he or she is unsafe to drive a vehicle. It was also decided that an alcohol breathalyser would offer the most appeal to the widest range of possible users. A layout drawing was produced to illustrate the preferred design. [Refer to Figure 73]

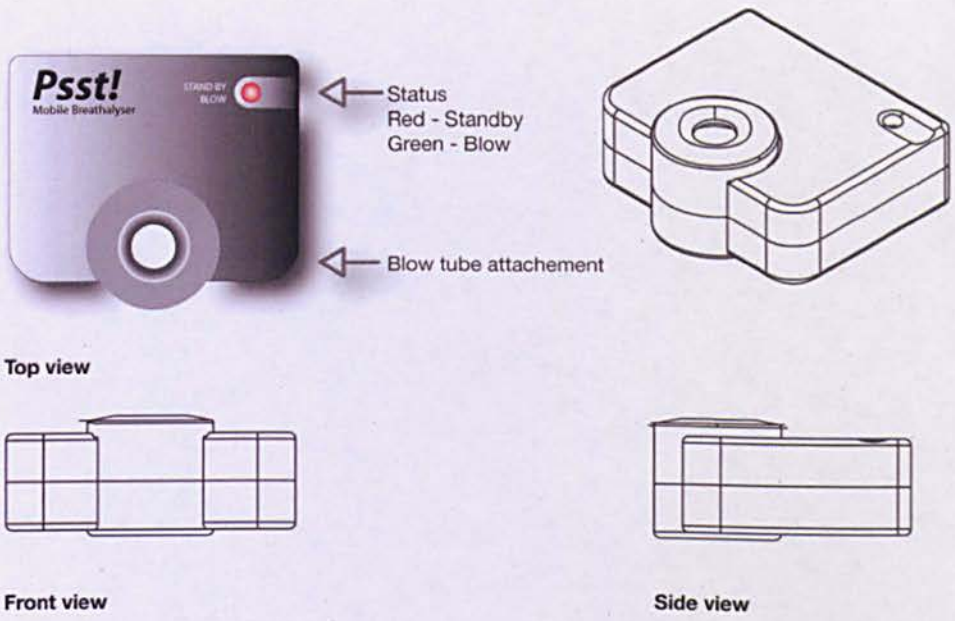

Figure 73: Preferred design - mobile phone - alcohol breathalyser

8.2.5_Documentation

A CAD workshop drawing was produced to enable an accurate appearance model to be made. [refer to Figure 74] Design documentation focused on the following design criteria.

> Volumes and form to match with mobile phone

> Ergonomic assessment

> Housing material and design details

> Control and interface

> The drawings and model were also used for design evaluation. [Refer to Section 8.2.7]

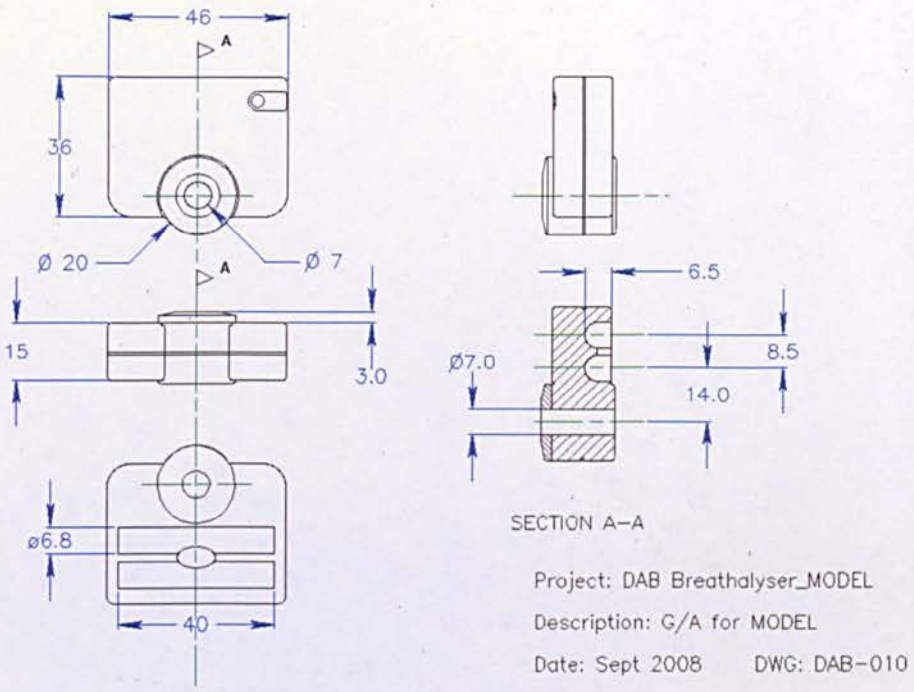

Figure 74: CAD drawing for model making (not to scale)

8.2.6_Design statement: Psst! mobile phone - breathalyser

Psst! is a plug-in module than enables specific types of mobile phones (with smart-phone capabilities) to be reassigned to function as an alcohol breathalyser. This is done by using the existing assets found within the phone, such as the battery, screen display, CPU, keypad and speaker. When the breathalyser unit is plugged-in to the terminal ports located on the base of the phone, it reconfigures the phone's operating system to function as a breathalyser. Both devices complement each other in terms of context of use, size and form, and to a limited extent, technology. With more than 1 billion handsets in use around the world and the average European replacing his or her phone every 18 to 24 months, phones are a plentiful resource for exploring the potential for Reassignment strategies.

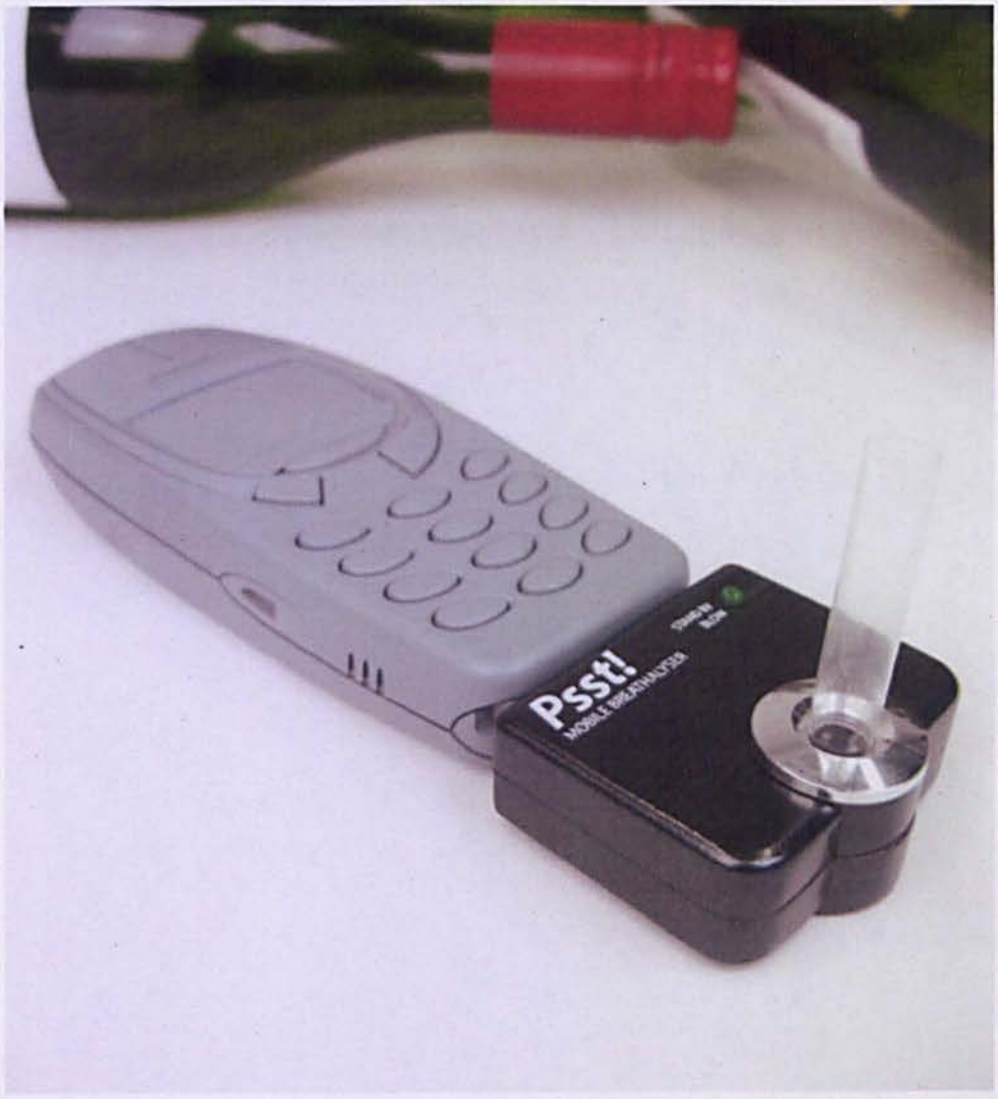

Figure 75: PSST! - alcohol breathalyser add-on unit [photo: author]

Figure 76: PSST! - Mobile phone - alcohol breathalyser in use [photo: author]

8.2.7_ Evaluation: Reassignment

This project attempts to show how the strategy of Reassignment can be applied to a mobile electronics device, so to extend its lifespan. As one evaluator noted: *"This concept has significant merit, especially given the volume of discarded and/or redundant mobile phones in the market."* He went on to say that "*mobile phones are a strong starting point for elaborating the model*". Another said: "*Using old computes or products such as mobiles as an 'engine' for other products is a good idea. Mobiles are great for this strategy because they are produced in such large volumes, they're small, and have on-board CPU, memory and screen.*"

The preferred concept, Psst!, combines elements of software programming with the addition of an addon module. While the emphasis of this research is on using obsolete products, a Reassignment strategy may be equally valid for other non-obsolete products to extend their functionality. Suggestions for other products could benefit from this strategy included, "*using old mobiles to drive a security camera ... and old mobiles to automate the transfer of data – e.g. vending machines*". Another suggested *"the [motor vehicle] service and repair industry also generates products and components that may be suitable e.g. tyres, oil filters, etc.*"

Evaluators were concerned about compatibility with host phones. One said: *"Unfortunately, for example, mobile phone connectors are currently brand specific and not universal, although I read somewhere that more commonality in mobile connectors is a likely in the future."* The proposed design would need to be compatible with the most popular types of mobile phone. The unit would need to interface with the Symbian OS, Java ME or Windows Mobile phone operating systems. The plug attachment terminal would also need to be compatible with a variety of phones according to each manufacturer, and to a lesser degree with particular phone models. This could be addressed by offering a product range of breathalyser units compatible with particular phones. Such an approach is common with other after-market phone accessory products.

One evaluator posed a rhetorical question about used terminology to describe the strategy. As this evaluator put it: "*How different to refurbishment and/or re-use is Reassignment? Is it the recoding of an existing product sustainability strategy, or is it something fundamentally different?*" Indeed is the question of difference or overlap relevant or critical anyway. This issue is discussed in Section 4.3.1, Section 7.1 and Section 8.2.

There was concern about the viability of a business model based on the "*availability of a specialised 'waste' stream product with reducing supply*".

However, this could be overcome by evolving the product over time to maintain compatibility with 'newly' obsolete phones models as well as finding markets as accessories for 'non-obsolete' products.

To conclude, one evaluator offered a more general and positive observation about the strategy: "*I believe the concept of Reassignment needs to be considered as part of a more sophisticated hierarchy in the European Union – a new way of approaching the waste-management hierarchy that reflects product sustainability in a smart and more commercially realistic manner. Maybe the time has come to move from 'reduce, reuse and recycle' to a more advanced model that more effectively reflects lifecycle thinking, business opportunity and overall socio-environmental benefit, including the role of behavioural change and outcomes that support and enable everyday sustainable consumption.*"

The evaluators agreed that the project clearly demonstrates the applied strategy of Reassignment in support to the findings to research question 4. [Refer to the beginning of Chapter 8]

8.3_Design Projects: Scripting

This third and final design project considers the strategy of Scripting. It entails designing a series of 'scripts' into a product as a means of guiding user behaviours and routines around a product. In this particular instance, Scripting is applied as a strategy to promote behaviour to prolong the lifespan of a laptop computer. For a more detailed account and examples of Scripting refer to Section 4.2.3 and Section 7.1.

8.3.1_Laptop computers

This design project illustrates the strategy of Scripting as applied to the design of a laptop computer. Laptops are particularly prone to both absolute and relative forms of obsolescence. As portable and delicate electronic devices, they are prone to damage, and often show accelerated signs of wear and tear. Impacts from falls, ingress of dust, spilt liquid, abrasion of external surfaces and vibration during transit can contribute to their gradual or sometimes dramatic decline into obsolescence. Unlike many desktop machines, laptops can be difficult and expensive to repair or upgrade. Moreover, technological change is a critical factor in determining the lifespans of these products, as evidenced by the percentage of discarded but still functional machines (Hai Yong and Schoenung 2006; van Nes 2003). Combined with the frequency with which new technologically enhanced models are launched and falling purchasing costs, these factors conspire to condition producers and consumers to believe that short lifespans are a logical outcome. This project is about disrupting this default position and behaviour towards obsolescence. In reconfiguring the laptop by embracing a range of design feature, the product can be 'scripted' to promote longer life. Scripting aims to guide user behaviour to circumvent the absolute and relative factors that can determine obsolescence.

8.3.2_Rationale and design brief

The aim of this project is to design scripts into a laptop computer to guide user behaviour, enabling the upkeep, maintenance, personalisation, technological upgrade or simple repair of the product. By enabling the user to perform these tasks, not only will the product be able to resist forces that can shorten its lifespan, but the user is likely to develop a 'emotional durability' (Chapman 2005) with the product.

Design brief

The scope of this project is to reconfigure the external materials, form and interrelationship between major components and subassemblies of a laptop computer. The established design language of the laptop computer should be maintained to enable the focusing on designing specific details of the machine. The design of software and the engineering of individual components has been excluded from the project.

Design criteria

> Devised Scripting actions to be undertaken by end user

> Devised Scripting actions requiring no specialist knowledge

> Reduce 'wear and tear' aesthetic obsolescence

> Enable easy replacement and upgrade of subassemblies

> Aesthetic resolution suitable for an item of precision ICT equipment, context and environment of use

> Design for long service life

8.3.3_Concept exploration

The concept sketch below represents a composite of a range of concept Scripts designs incorporated into the laptop computer. [Refer to Figure 77] Specific elements of this concept sketch overview are discussed below.

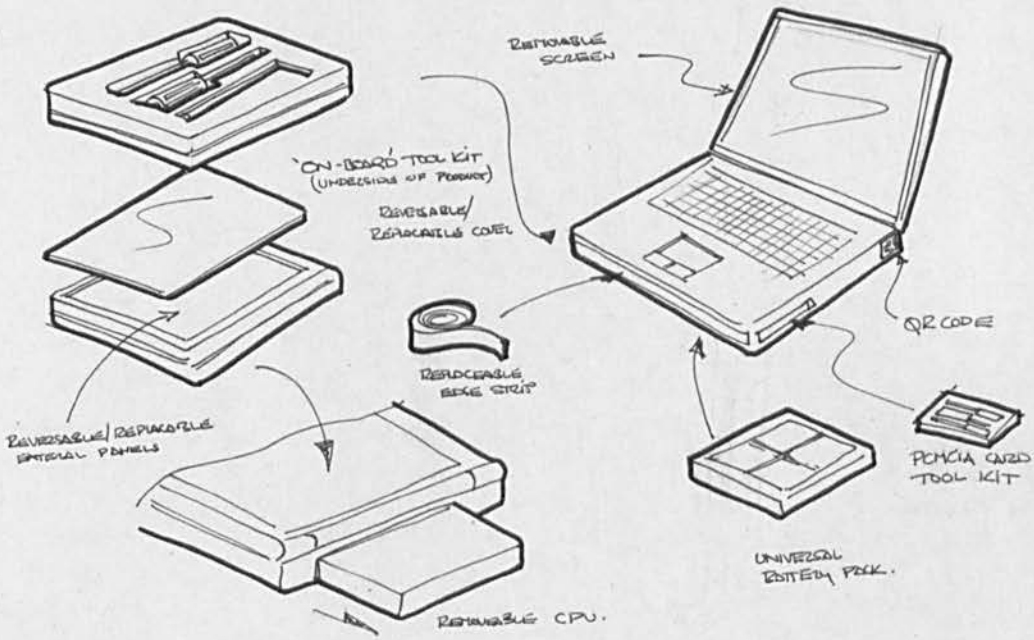

Figure 77: Sketch overview of Scripting strategies for a laptop computer

On-board tool kit

Recessed into the base of the machine is a set of tools allowing users to access and remove certain subassemblies. The tools clip into a tray that remains hidden and recessed within the underside of the laptop. The provision of such tools contains the script of allowing and validating the user to carry out specific tasks on the laptop. Tasks could include cleaning and minor repairs, and changing or upgrading components. The provision of on-board tools is analogous to the tools provided with passenger vehicles for changing spare wheels, fuses and for carrying out other minor maintenance activities.

PCMCIA tool kit

A variation of the above feature, the toolkit sits in a small tray that resides within the PCMCIA slot. These tools would not be dissimilar to miniature jewellery screwdriver sets. To access the tools, the PCMCIA card removal button is depressed, dispensing the tool tray.

Reversible / replaceable external panels

The provision of reversible or replaceable top panels allows the user to change, reverse, customise or refurbish the laptop's external panels. The script contained within the reversible/replaceable panel encourages and validates the user to contribute to the product's evolution. The flat panel dimensions are 297mm x 210mm, the same dimension as an A4 piece of paper. Thus the panel may be replaced by a clear sheet providing a framed recess for mounting an A4 sheet for personal expression.

Replaceable edge strip and keyboard

Edges and corners of any portable product are invariably the first to show signs of wear and tear. By providing soft elastomer edge strips, aesthetic deterioration can be slowed. The provision of edge strips offers a ruggedness to the product that can greatly reduce visible signs of wear and buffer the laptop from minor falls. As well as being replaceable, the edge strips are also reversible so the unblemished inside edges can become the new outer edges. This enables the user to refresh the product without having to source new components. [Refer to Figure 78] The removable keyboard also facilitates easy cleaning of dirt and grime known to accumulate in crevices in around the keys..

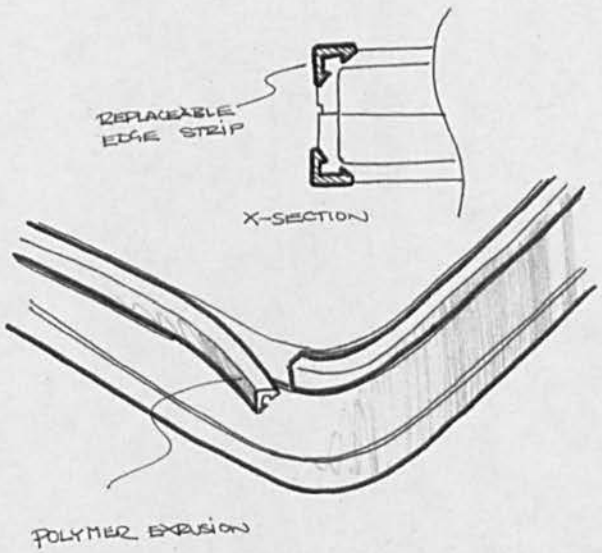

Figure 78: Sketch detail of replaceable edge strip for a laptop computer.

Universal battery pack

Battery packs are commonly one of the first components within a laptop that require replacement because of their gradual decline in performance[34]. Although replacement is often a simple exercise performed by the user, a specialised, expensive type needs to be bought. Sourcing replacement batteries for older machines can be challenging because of limited availability. When such batteries are available, they may be in poor condition because of their having aged in storage.

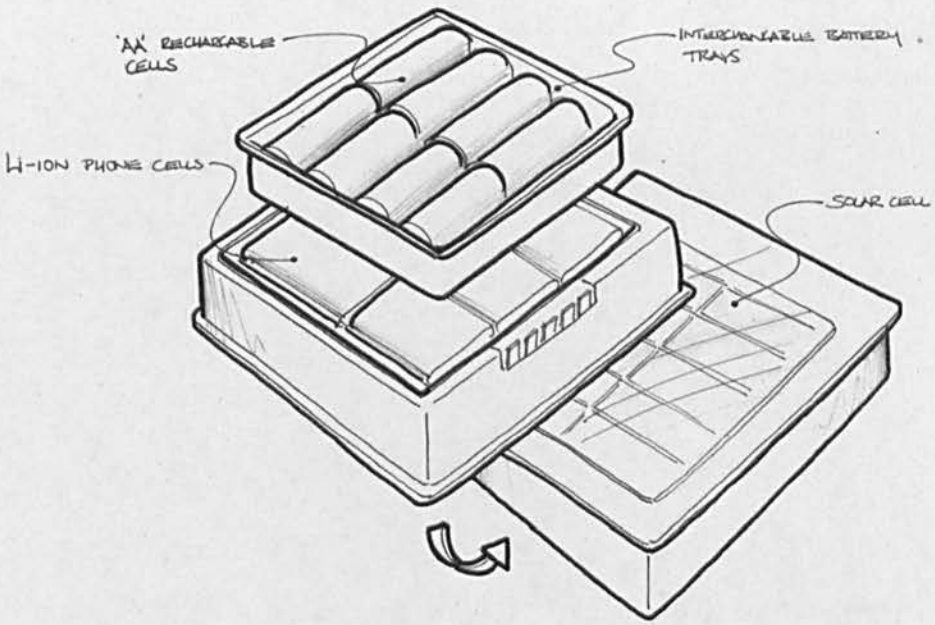

Figure 79: Sketch detail for laptop battery trays

The proposal for a universal battery pack is to provide battery shells that can be loaded up with a variety of readily available smaller cells. [Refer to Figure 79] This could include an array of mobile phone battery packs or high-capacity rechargeable AA cells. A variation of this proposal is the use of multiple battery pack shells that have a built-in photovoltaic cell that can trickle change the cells within the pack and keep them in peak condition when not in use. The spare shells are left in a sunny position near a window awaiting use.

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[34] A lithium-based cell, the most common type of laptop battery, will maintain 80 per cent of its performance up to 300 full charge and discharge cycles. After this, its ability to hold a change will gradually diminish.

Removable CPU subassemblies

The PCB (printed circuit board) CPU (central processing unit) is often configured to allow for some customisation during manufacture and limited upgrade during use. However, the end user rarely undertakes such activity without specialist knowledge. The most common type of upgrade is the addition or replacement of RAM[35] modules. On some types of laptops, the user can easily undertake this task with limited technical knowledge. However, the process still requires the use of tools and an awareness of dealing with delicate electronic components. Other CPU elements including video cards, WiFi cards and even the CPU chip can be upgraded, but require a much higher degree of specialist knowledge. The Scripting feature proposed within this project entails the provision of a removable cassette with the PCB CPU mounted within. When removed, the cassette offers direct access to key components for the user or could be exchanged for another one.

Removable screen

A common fault that emerges in many laptops concerns the screen. Screens are delicate subassemblies, susceptible to scratching and surface marking, cracking, pixel dropout and backlight failure. The hinged screen panel, catch and electrical connector ribbon are also prone to mechanical fatigue. Due to its complexity when a screen is damaged it is often uneconomical to repair.

The proposed scripted feature is for a screen that can be removed by the user. All hinge and electrical connections are combined in a plug-in co-axial pin arrangement. The screen can be removed for cleaning, swapping for repair, storage (if an external monitor is preferred) or reversal for presentations. [Refer to Figure 80]

[35] Random Access Memory (RAM) modules are common after market products that can be a cost effective means of improving performance of a computer.

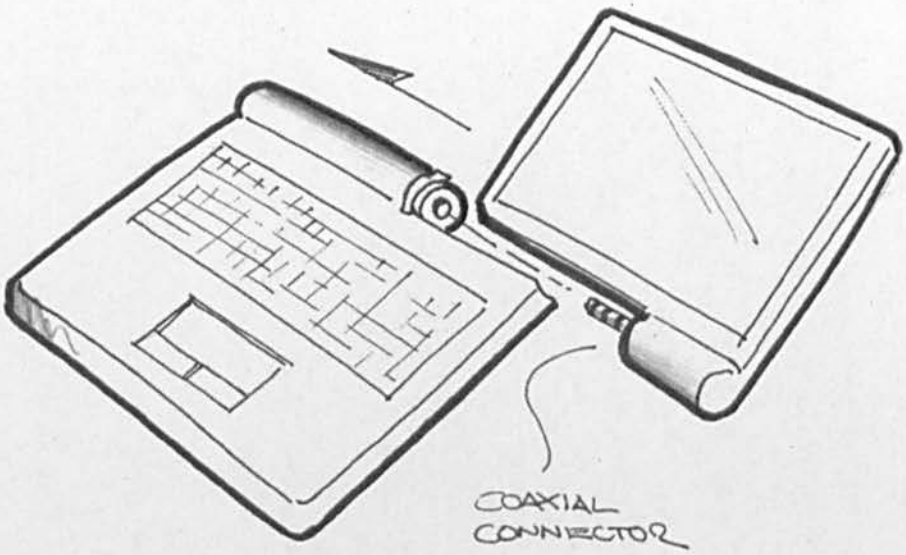

Figure 80: Sketch detail of removable laptop screen

QR codes

QR[36] codes are a matrix barcode system that can be decoded by a mobile phone equipped with appropriate software. Their advantage over linear barcode systems is that they contain much more information. They could enable product information – such as user manuals, spare part and supplier information – to be retrieved. By placing QR code graphics at strategic points on the laptop, the user is able to retrieve part(s) or product information without needing to locate a manual or search for suppliers. [Refer to Figure 81]

Figure 81: QR Code

[36] Quick response (QR) codes are common in Japan were they were first developed in 1994. They offer a much higher information density than standard barcodes while sharing similar benefits.

8.3.4_Design development

A General Assembly drawing was produced combining the various concept elements as discussed above. Although many technical aspects of the project are not communicated in the General Assembly drawing [Refer to Figures 82 and 83], the drawing offers identification and overview of each Scripting element presented in the unified product design.

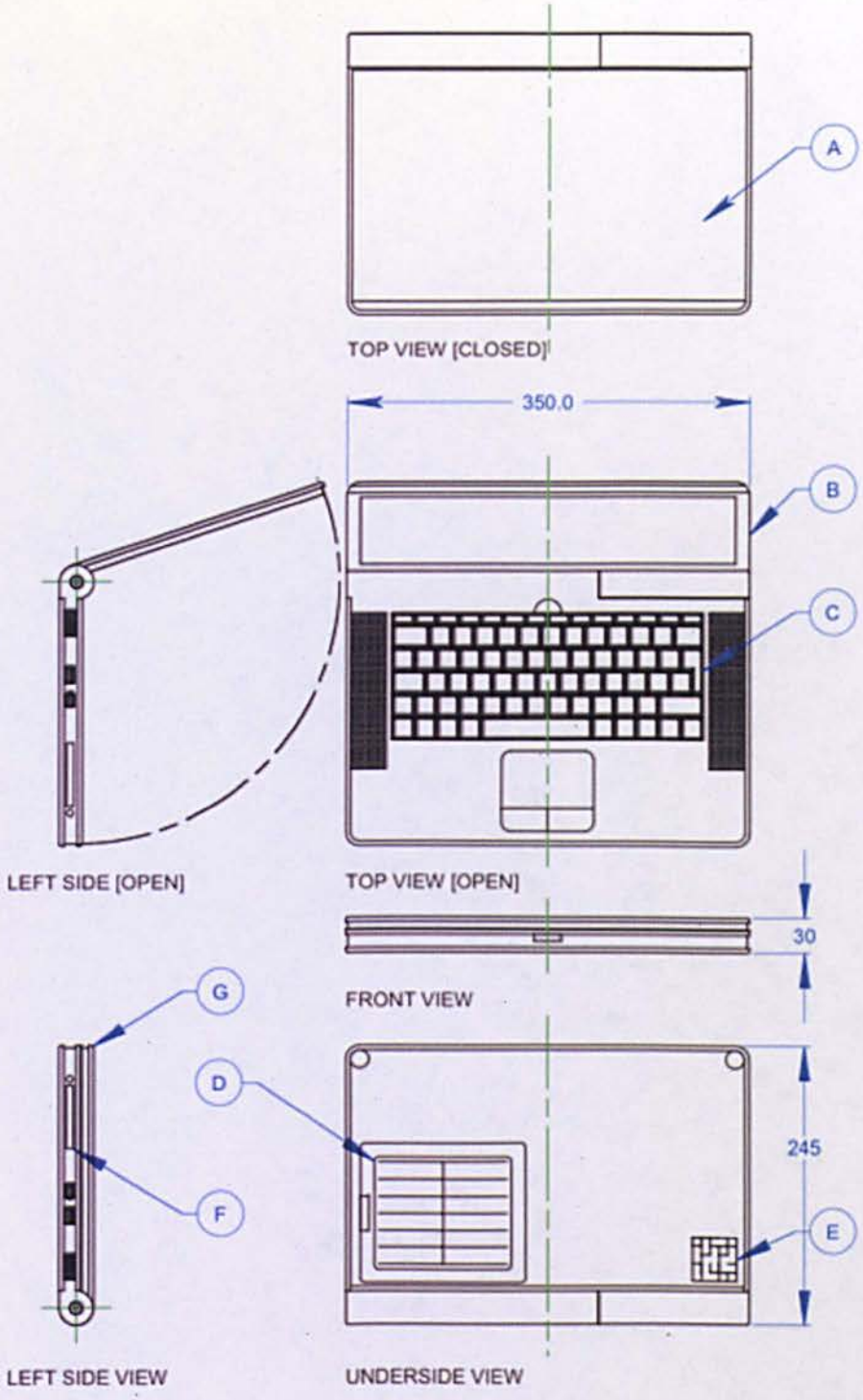

Figure 82: Laptop computer General Assembly [not to scale]

Part	Description	Comments
A	Top facia panel	Reversible & replaceable ABS / Textile / Leather or Laminated paper
B	Screen	Reversible & removable Co-axial pin connection
C	Keypad	Removable for cleaning
D	Battery tray	Swappable for use of alternative battery trays and solar charging
E	QR code	Labels on all major sub-assemblies
F	'On board' tool kit	PCMCIA card slot
G	Edge strip	Reversible & replaceable

Figure 83: Major components

8.3.5_Design statement: LaptopLife

LaptopLife combines a number of scripted elements to enable the prolonging of the lifespan of a laptop computer. Replaceable edge strips and facia covers enable the product to be refurbished or customised in appearance without specialist knowledge. This is further enhanced by a non-tool removable keypad for cleaning and repair. An on-board tool kit enables the replacement and upgrade of internal components, including RAM. As well as the standard lithium-ion battery, supplied with machine, spare battery trays are provided, each with a built in solar battery charger. Each tray is designed to suit commonly available rechargeable cells such as 3.7volt mobile phone cells and the more common AA cells. The screen is mounted via a co-axial pin plug providing easy removal for repair or replacement. All major subassemblies are labelled with QR codes that contain relevant (for the user) product information, such as supplier details and web links for upgrade and repair.

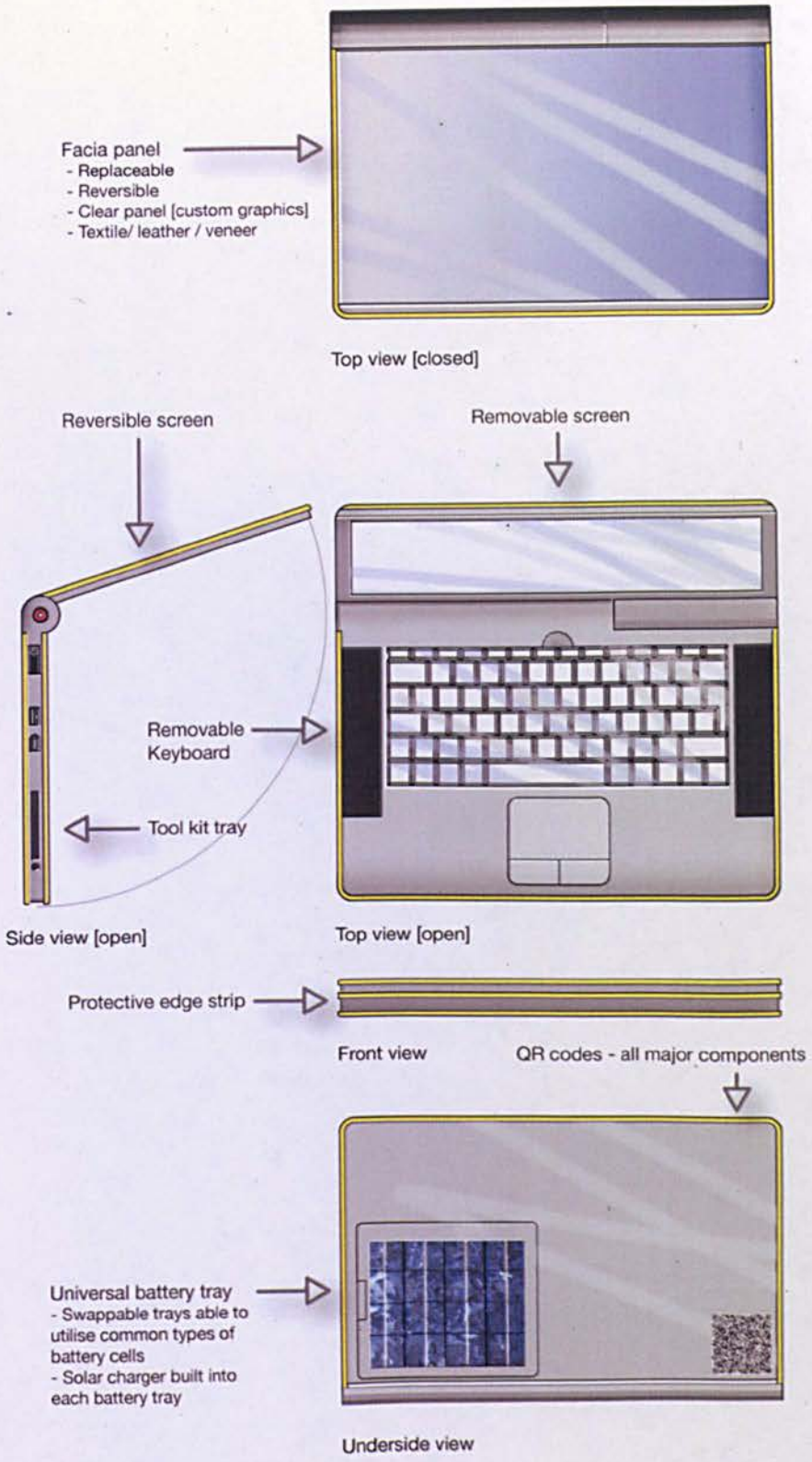

Figure 84: LaptopLife - product features

8.3.6_Evaluation: Scripting

Unlike the technological focus of Piggybacking and Reassignment strategies, this project attempts to directly engage with user behaviour to prolong product life. LaptopLife offers an open product architecture that is adaptable by the user to meet changing circumstances and maintenance needs of the product. This project combines elements of ecodesign strategies such as modularisation, upgradeability, reparability and customisation that have been moderated though the use of scripts or prompts to guide user behaviour.

Despite the shortcomings of the pilot project that explored Scripting, evaluators responded enthusiastically towards this Scripting design project. *"Strategies that enable and facilitate effective, efficient and no-cost/low-cost user maintenance, repair, cleaning, etc, are strategies that are timely i.e. economically sensible, socially desirable and ecological necessary. Product life extension that is enabled through Scripting makes sense and also motivates a more informed user – object interface or relationship. Effective product service and maintenance nearly always extend product life and/or maximise product functionality, reliability, safety and performance. A strategy such as Scripting that helps to achieve such outcomes is significant and should be further developed, refined and advocated"*

The proposal for an onboard toolkit was particularly well received, with one evaluator saying: *"Scripting is a great idea. I regard the 'onboard toolkit' element as significant, innovative and very practical. The design of vacuum cleaners in recent years has successfully exploited the onboard feature quite well, as have car manufacturers for many years.*

It was noted that Scripting could work well with *"upgradeable components, software and user changeable, use defined components"* and with *"products which have intrinsically long life spans, and /or elements of fashion, tactility & wear in use"*. It was also said that *"the Scripting philosophy makes good sense in several business areas"*, as was the appropriateness of Scripting for the *"vast majority of manufactured goods"*. Including vacuum cleaners and cars, as mentioned above.

A key challenge identified by one evaluator was how to get producers to support and apply such a strategy. It was felt there would be a resistance to, for example, extra labelling. *"Thus, the need to regulate for such socially and environmentally beneficial outcomes would be worthwhile and necessary to capture recalcitrant producers."*

In conclusion, Scripting was one of the preferred and most commented upon strategies. This was a surprising finding as the project was the least advanced

design solution of the three projects and produced poor results during the pilot project. One evaluator concluded: *"It may be that Scripting works more effectively where there are products with potentially short lifespans that could be extended if user guidance is bolstered etc ..., I believe that Scripting has potential and value across all product types ... in addition to consumer electronics. User-friendly instructions, onboard toolkits, spares, cleaning advice etc ... is a positive life extender in all product categories*". Thus it could be concluded that the project successfully articulates a response to research question 4. [Refer to the beginning of Chapter 8]

PART 3: Synthesis

9_Analysis and evaluation

This section discusses key findings, recurrent themes and future work arising from this research. It starts with a summary of key findings from the Piggybacking, Reassignment and Scripting design projects. Recurrent and emergent themes are then discussed linked to the literature, theory and product life-span examples as discussed in Chapters 2 and 3, with practical design projects discussed in Chapters 6,7 and 8. Key findings of this research centre on the interdependence of technological change and obsolescence, the need for transitional lifespan solutions and redirective design practices that can create open products that are adaptable by users to manage changing circumstances.

9.1_Research projects key findings

Following a review of the literature on product obsolescence and the identification of examples of prolonged product lifespans, three separate research projects were undertaken. This section summarises the key findings of each.

Using and Consuming

The Using and Consuming project was the first involving 16 participants attending the 10th Sustainable Design Network seminar, Design I Behaviour. This project offered an opportunity to make the proposition by asking 'what if'? As opposed to the previous role of the literature review and survey of examples by asking 'what is?' A key finding from this first project was that the most commonly proposed strategy involved a variety of PSS solutions. Such strategies were proposed across a rage of reference products with little discrimination between electrical and non-electrical items. In certain instances it found that designers and users respond to obsolescence in a similar way. However, this project demonstrates that users can be equally important in determining the lifespan of products.

Pilot design project

The pilot design project followed. It focused on applying three specific design strategies to a structured design projects. It involved Year 2 product-design students from the University for the Creative Arts participating in a four-week design project. Despite students having little or no previous experience in using product lifespan strategies, the pilot project found that specific product lifespan strategies could be incorporated into design projects. Of the three strategies applied, it was found that the Reassignment project (of a mobile phone) resulted in the most successful outcome. It was concluded that the strategy of Scripting was the least successful because of the disappointing project outcomes. Students

struggled in comprehending and expressing, in the embodiment of a script in a product design.

Design projects

The third and largest research component was the application to structured design projects of the three piloted strategies, The three projects, undertaken by the author, were documented in detail using a structured and a transparent design process. Consistent with the findings from the pilot project, it was found that the most successful projects involved the strategies of Piggybacking and Reassignment. In both instances, a range of technical, functional and human factors were able to be resolved resulting in detailed product forms. The design finalisation of each project varies. Piggybacking and Reassignment projects were undertaken to a much higher level of technical completion than Scripting. For example, Piggybacking is clearly defined by technological parameters where obsolescence is largely determined by changing radio broadcasting technologies. The project requires a technological response to demonstrate how obsolescence can be overcome. On the other hand, the Scripting project is concerned with a looser set of priorities that are aligned with guiding user behaviour. It could be concluded that Piggybacking and Reassignment strategies primarily contend with the technological aspects of obsolescence, while the strategy of Scripting explores guiding behaviour to contend with user determined relative forms of obsolescence. The evaluation of the three design projects was favourable. As one evaluator put it: "*Each has a role and place depending on market, geography, post-consumer opportunities.*" Unlike the Scripting project undertaken by design students in the pilot study, another evaluator concluded that Scripting was potentially the most successful strategy to extend product lifespans:

> *"If I had to pick one (strategy) based on current thinking and information, I believe that Scripting has potential and value across all product types ... in addition to consumer electronics. User friendly instructions, onboard toolkits, spares, cleaning advice etc., etc. ... is a positive life extender in all product categories."*

9.1.1_Comparision to other research in the field

There exist three recent research contributions to the field of product lifespans. The most comprehensive being the recently completed EPSRC funded project *Network on Product Life-Spans* led by Dr Tim Cooper. The concluding report from the network states that, 'further work on typology and terminology is still needed to capture people's imagination, develop concepts and describe phenomena' (Cooper 2008). This research contributes to this call for further work by developing understanding of design strategies that can prolong the products lifespans.

Two other notable contributions in this field are Doctoral theses by Dr Anne Marie Chalkley and Dr Nicole van Nes. Both have investigated product lifespans and associated environmental impacts. Chalkley's (2003) work investigates when it is ecologically beneficial to replace a product for another more energy-efficient one. She uses the concept of 'optimised' lifespans. Not dissimilar van Nes (2003) assesses the environmental desirability of longer lasting products by quantifying 'environmental desirability' and 'replacement motivations.' She introduces the concept of 'ecological obsolescence'. This is where a product is retired in favour for a more environmentally benign replacement.

This research thesis sets itself apart from the approaches adopted by Chalkley and van Nes. Its findings suggest that it is user behaviour that determines product life. Product life does not reside as a preset condition within a product, but should be embedded within a product so it can be 'adaptable' to the changing needs and circumstances of users. In addition, it is argued that replacement of products in pursuit of improved energy-efficiency can backfire as well as encourage a change of user behaviour. The intended energy savings designed into a product can 'rebound' where energy use can increase as consumers adjust their behavioural use of a product. [Refer to Section 2.6.3]

A further distinction of this research is that it incorporates design projects by adopting a research-through-design methodology. Design projects offer illustrative and instructive examples of how strategies can be developed to prolong product life.

9.2_Recurrent and emergent themes

Drawing on the literature, examples of product lifespans and the research-through-design projects, recurrent and emergent themes have been identified. Some are familiar and well established in the literature on product lifespans, while others are new and emergent. Established themes include the prevalence of technological obsolescence in consumer electronics sectors and the reoccurrence of PSS proposals to mitigate obsolescence. Emergent themes identified within this research include, defining where design happens by delegating or creating design opportunities for the user, and the transitional role of lifespan strategies in enabling the technological lifespan extension of a product. These are discussed below, starting with a discussion on the significance of technological change and product lifespans.

9.2.1_Technological determinism and obsolescence

A discrepancy exists between technological change and a product's wear-out lifespan. A computer may easily last several years, however the technological cycle of change is only 1 ½ years (Rose 2000). In product sectors such as consumer electronics technological change is inseparable from obsolescence. Often it is a direct cause of obsolescence as experienced with step changes in technology, such as the change from wet film to digital camera technologies. Equally, technological change can manifest as an indirect cause of obsolescence. It may be embedded within a parcel of other factors where technological change can cascade and trigger other reasons for obsolescence. For example, the introduction of new technologies often results in a decline of manufacturing costs that may be passed on as a reduced purchasing cost. New technologies are increasingly complex, with many advanced products uneconomical to repair. Despite the improved reliability for many of these products, they are no less vulnerable to obsolescence. The cost of repair and perceived difficulty in obtaining replacement parts can feed into other subtle forms of obsolescence. New technologies also make older ones 'appear' obsolete. The creation of self-identity and social comparison with more technologically advanced peers, along with product shabbiness (wear and tear) can accelerate obsolescence by creating new wants to satisfy (Campbell 2006; Hirsch 1977; Jackson 2004; McCracken 1990). [Refer to Chapter 2]

Any strategy devised to prolong the lifespan of consumer electronics will need to address the prevalence of rapid technological change, whether it be a incremental

or a radical step change in technology. The three strategies as applied to projects within this research each address technological obsolescence in varying ways. Piggybacking offers a way of transitioning a product between old and new old technologies – one in decline and the other in ascendancy. Such a strategy may be most appropriate for radical step changes in technology as encountered with the shift from analogue radio broadcasting to digital broadcasting services.

Reassignment also directly engages with technological change by offering a means of stepping out of one technological context into another. The Reassignment project documented in Chapter 8 shows how a mobile phone can be redeployed to perform an entirely new function. It migrates the product from one technological context that is evolving and changing rapidly (mobile communications) into another technological context (mobile breathalyser) that is less troubled or dependant on rapid technological change. Both Piggybacking and Reassignment enable the user to adapt products to prolong product life through prescribed actions.

On the other hand, the Scripting project involving a laptop computer mediates an open, user-centred engagement to manage technological change. The product is configured to enable the user to perform a range of lifespan- prolonging activities. Some activities are technologically dependant, such as the replacement of obsolete subassemblies found within the product. In this instance fast and slow technologies are evened out. (Thorpe 2007; van Nes 2003).

Complementary to the design strategies discussed within this research and counter to the many factors that conspire to accelerate obsolescence, technology can also be harnessed to prolong product lifespans. In Section 4.4.4, the potential of technologies such as reprogrammable products, of communications networks and digital fabrication techniques are discussed. Integrated into communication networks, consumer products could enhanced in a similar way as computers have developed by linking together through wireless LAN (local area networks), GPS (global positioning system) navigation, RFID and GSM (Global System for Mobile communications) networks. With onboard intelligence, in the form of embedded electronic systems, a product could reveal information such as operational instructions, spare-parts suppliers, hours of use, and provide a fault detection-log, energy-consumption management . . . and could even offer spatial location and tracking. The potential of convergent information technologies can offer a way of measuring and managing, either locally or remotely, the lifespan of a product.

Further to this, digital technologies are opening up other opportunities to prolong product lifespans. Increasingly, rapid prototyping technologies such as selective

laser sintering (SLS) and stereolithography are making inroads into the world of manufacturing. A key feature of these technologies is that they can produce customised individual or short-run production parts that requires no tooling (Hopkinson and Dickens 2006). It is conceivable that as the cost of rapid manufacturing technologies fall and the quality of production parts improves, replacement parts, accessories and customised components could be produced locally, where needed and as required, at low cost. Future households could own a desktop 'personal fabricator' that could be used to 'print' parts on demand, not dissimilar to the way a computer printer prints documents as required (Sterling 2005).

9.2.2_Transitional lifespan solutions

This research has focused on the selection and application of three specific product lifespan strategies. While it can be observed that each strategy can be successfully applied to a consumer electronics design project, it's not known if such strategies can mitigate product obsolescence over the lifespan of the product. To determine this would require a long-term longitudinal study tracking products throughout their life. Because of cost and logistics, few, if any, empirical studies of this kind exist. However, an implied objective of the applied strategies is not to achieve an indefinite life-extension but to slow consumption by restoring a balance between obsolescence and technological change. This may seem a modest objective for certain product categories, but for the fast-moving consumer electronics sector, it presents a considerable challenge.

The three investigated strategies offer a means of slowing obsolescence within the constraints of the existing linear economy. Each strategy has a role to play in the transition of technological change. This change may be incremental, where a technology evolves slowly through the addition of new product features and functional novelties. Or it may be radical where technology undergoes a step change. In the instance of the Piggybacking project, the introduction of DAB (as typically experienced with other digital technologies) represents a step change. In the instance of the Reassignment and Scripting projects, technology change is often less abrupt. The chart below [Refer to Figure 85] illustrates how applied strategies can extend the lifespan trajectory of a technology within a product. Sunset technologies are in decline to be replaced by a new sunrise technologies in ascendancy. Piggybacking, Reassignment and Scripting strategies can prolong the lifespans of product during transitional technological change.

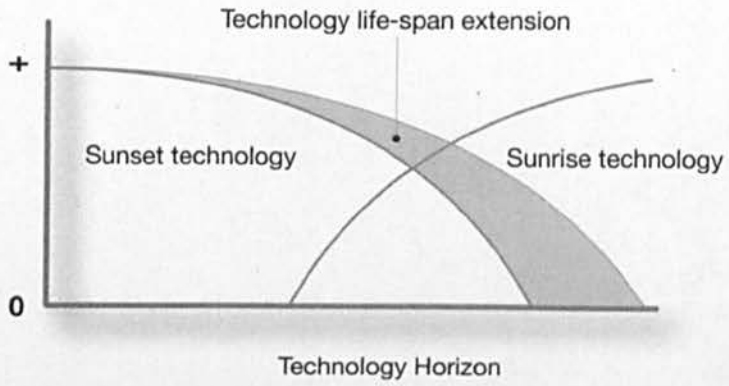

Figure 85: Extending technological life-spans

There are many opportunities to intervene where technological change is taking place. Lifespan strategies can become a catalyst for product innovation by exploiting new product niches created at the boundaries of sunrise and sunset technologies. These opportunities include the rapid switch from wet-0film chemistry to digital photography, the rapid changeover from analogue to digital broadcasting technologies, or more gradual transitions such as consumer interest in energy-efficient lighting technologies and hybrid-fuelled engine technologies. Looming technological obsolescence can become an opportunity for innovation and not predetermine the end point of product lifespan.

9.2.3_Where design happens

> *I have no idea why we think of design and architecture as strictly vocational study areas* (Papanek 1984).

The idea that all human beings are designers is often forgotten. Our ability to 'prefigure' (to form or shape) is a characteristic that defines us as humans (Fry 2009). However, the widely accepted view is that design is predominantly undertaken as a professional activity. The persistent and prevalent idea is that designers embed economic, ergonomic or semiotic value in objects (Shove, et al. 2007). As 'givers of form' and through the shaping and manipulation of materials and technology, the designer is said to determine the value and meaning within a product. [Refer to Figure 86] In such a situation, the user is relegated to a passive role and not contributing to the value or meaning within a product. The user is effectively locked out of the process.

Figure 86: A persistent view of design

Designers try to project a 'world inscribed' within a product (Akrich, 1992). However, a designer's intent on how a product is to be used is not always acted out as inscribed. The social sciences and consumer psychology theorise on how people relocate their feelings and desires in products and act out narratives other than those conceived by the professional designer (Shove et al. 2007; Jackson 2006; Ilmonen 2004). For example, this can include a creative relationship with products through appropriation, customisation and personalisation. This research postulates the opportunities that these and other observations – presented within this research – offer as a way of extending product lifespans. It acknowledges that design can and does happen elsewhere. It explores the opportunities for repositioning the role of design to the user. In such instances, product value (to the user), its meaning and physical attributes can be renewed, maintained or evolved so to prolong product life. To enable this, a product needs to be adaptable to meet particular and changing circumstances. This suggests the role of design shifts from the exclusive realm of the designer to one in which the designer delegates a role for the user to contribute to the product's ongoing design. [Refer to Figure 87] Product value is not locked in and inscribed within the product, but resides in the relationship between people and things (Shove, et al. 2007). The strategy of Scripting offers an example of how the delegation between (professional) designer and the user could take place. Clear boundaries are established with the product configuration offering the user a clear and logical 'script' on how to renew, maintain and evolve the product.

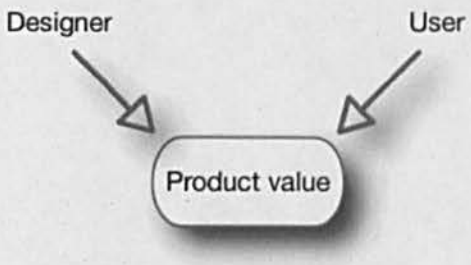

Figure 87: Designer and user collaborate to create product value

9.2.4_Adaptive design

Informally, tinkerers [Refer to Section 4.3.4] and other individual behaviours offer examples of how users create product value that can extend product lifespans. On a slightly more organised level, groups are emerging that are dedicated to the idea of creating new product value. They promote the idea of redesigning and co-evolving a product by describing such activities as mashups, product hacks and repurposing (Instructables 2008; Make 2005). [Refer to Chapter 4] On one hand, this activity celebrates a playful creativity and satisfaction for users to be able to repair, reconfigure and personalise objects. It represents a 'design amateurism' (Hill 2004) where the user is purposely engaged in adapting a product to suit his or her particular needs and circumstances. On the other hand, this activity represents a more potent message where permissions and authority are wrestled away from the designer/producer of the product. This represents a 'politics of products' whereby users challenge the dominant and authoritative role of the designer/producer by purposely subverting the function and prescribed role inscribed within the product. These activities often take place outside professional routines and practices. They are often creative and organic, and sometimes collaborative in the way they evolve, change and fade (Shove et al. 2007).

To borrow from the terminology of the World Wide Web (www), this activity represents a form of user-generated content that defines what is commonly referred to as Web 2.0[37]. This model of user-generated content in online environments is worthy of further discussion because of its redirective design practices that shift design practice to the user. Users create the content on websites such as Facebook, flikr, YouTube and Blogger, representing a significant shift in where production is located; content creation is reallocated from the 'professional' to the 'amateur' (Leadbeater and Miller 2004). The significance of this is not lost on many of the traditional multimedia news and entertainment media corporations who see the media landscape transforming around them. New business models are evolving on how its potential can be harnessed and managed. In many instances, delegation to the user 'to design' is tightly controlled; boundaries are clearly defined by commercial interests. However, such shifts also occur in open and fluid environments, where the fundamentals of ownership are decentralised, and rules of engagement are often self-governing. Online

[37] The term Web 2.0 describes a combination of elements including user-generated content, open source software and user participation. Websites such as flickr, YouTube, Facebook, Wikipedia and eBay rely upon a perpetually evolving design architecture where the user creates the content (Musser 2006).

environments again offer good examples. The growth of open-source software such as Mozilla and user-content platforms such as Wikipedia represent the respectable side of noncommercial user-generated content. At the other extreme computer hackers represent a more exploitative and sinister manifestation of user-generated content.

However, 'hacking' is not just confined to computer environments, and it can be applied to products without malicious intent. Product hacking is a way of describing a type of user appropriation and intervention. It is a process of 'creative misuse' (Hill 2004) in which the user adapts a design outside the parameters defined by the professional designer. In such instances, the role and activities of the respective co-producers (the professional designer and user) remain unspecified and largely in ignorance of each other's respective activities.

Formalising a user-centred approach to industrial design could have a profound effect on the way we acquire, consume and discard products. This would require products to be adaptable by the user. An adaptive product requires the designer to create a product that is intentionally 'unfinished' or 'open'. The user then becomes a co-producer in the design of a product in a continual process that is contextually relative, situationally specific and inherently reconfigurable. It requires a two-way traffic between the designer and user for this relationship to evolve. The role of the designer still remains principal, but is broadened to consider a shared role of design delegated to the user. This delegation may be confined to a set of defined prescriptive actions (such as Piggybacking or Reassignment strategies) or offered as a more open-ended field of user-determined possibilities (as with a Scripting strategy) in the pursuit of prolonging product life.

9.3_Designing open products

Identified throughout this research is the importance of the user in determining product lifespans. It is also proposed that products that are adaptable to changing circumstances are better able to avoid obsolescence. This can be achieved through the design of 'open' products. Openness enables a product to be adaptable by users to meet their changing needs and circumstances so to minimise obsolescence.

An open product should offer 'perceived affordances' (Norman 2000) or intuitive and logical scripts to the user. For instance, affordances could include product housing assembly fastenings that are easily locatable, removable and reusable. Product materials and finishes could also be configured to enable ease of

maintenance, repair or customisation. Through strategies such as Scripting, guiding user-centred routines and actions can be inscribed within a product to promote, for example, maintenance or clearing routines. The Scripting project explored in Section 8.3 presents concept designs for various scripted user adaptations that can take place within a laptop computer. The laptop computer project contains both open and closed scripts. Open scripts offer open-ended possibilities for user adaptation, while closed scripts guide more prescriptive user actions.

The Piggybacking design project [Refer to Section 8.1] demonstrates how a technologically 'closed' product can be 'opened' through the addition, by the user, of a DAB piggyback unit. While the designer is central in determining the form and function of the DAB piggyback module, the introduction of the piggyback unit provides the means of opening the existing product. The designer of the DAB unit delegates a specific and prescriptive role for the user for product adaptation.

Similarly, the Reassignment design project offers the user a means of adopting a product for a new purpose. [Refer to Section 8.2] In this particular case, it involves the Reassignment of a 'closed' mobile phone that offers limited scope for user adaptation. By offering an additional component, the product is 'opened', to the user to adapt the product for a new purpose.

For industrial design, the idea of open products offers new opportunities for design innovation by enabling existing products to become adaptable by the user through the design of add-on units, or through the design of new products that are open to user adaptation to better meet individual circumstances and changing needs. Such an approach could enable companies to create closer relationships with their customers, enable a better product-fit to users' needs and help prolong product lifespans. This is particularly relevant in fast-moving sectors such as consumer electronics where product lifespans are short, and user adaptability is increasingly expected. This will also require regulatory support and business innovation – perhaps along the lines of the user-generated content business models emerging in online environments.

9.4_Contribution to knowledge

This research contributes to the fields of sustainable design, industrial design practice, innovation in specific product sectors and design research. Its contribution to sustainable design is through addressing the neglected topic of the lifespan of products. By doing so, it opens up a new field of design practice that explicitly

places the user at the centre of design. These 'redirective' practices require an understanding of social norms around product lifespans and forging new user behaviours through strategies as explored within this research.

This research contributes to design practice through the identification and application of new strategies. By doing so, it opens up new opportunities for product and business innovation in specific product sectors. [Refer also to Section 9.5 below] For example, DABlife is a new niche product category that offers further opportunity for development and commercialisation. The product spans the technological transition from analogue to digital radio services.

Lastly, this research offers a document of design research. It contributes to the field by offering an example of an applied research-through-design methodology. It offers an example to others of how design research can be applied to address research questions. It states research questions, selects appropriate methods, enables analysis and discovery and is accessible by others. [Refer to Section 5.2.2]

9.5_Wider applications in practice

The environmental performance of products are increasingly being scrutinised by consumers and regulators. Manufacturers can no longer afford to downplay environmental impacts or make unsubstantiated 'green' claims about their products. As the energy efficiency debate matures, attention is turning to other aspects of the lifecycle of products. Supply chains and end-of-life practices are the typical candidates for attention, but the need to address the declining lifespan of many consumer products is worthy of equal attention. Product life has been a neglected part of the product lifecycle equation. This research contributes to bringing product life back into focus. It offers new strategies for design practice and new product innovation. A wider implication of these new practices is opening up the possibility for new business models based upon PSS. Combining the design of new 'open' products that are adaptive to users changing needs with the design of services that support the ongoing utility of a product opens new business opportunities. This can broaden the service offered by industrial designers - especially in post-industrial nations such as the UK where the manufacture of consumer products is in decline

10_Conclusion

This research attempts to reveal how design strategies can prolong product lifespans. Three particular strategies (Piggybacking, Reassignment and Scripting) have been investigated through a research-through-design methodology - resulting in illustrative design projects. These projects illustrate and instruct how specific strategies can be applied to the problem of product obsolescence and create the stimulus for new modes of design practice and innovation.

10.1_How research questions have been addressed

The aim of this research is to identify and develop an understanding of strategies that can prolong the lifespan of products and thereby apply such strategies to structured design projects. This has been achieved through the completion of a series of objectives. [Refer to Section 1.1] Notably, through a mixed research methodology comprising of a literature review and a series of research-through-design projects. The literature review in part one of this thesis establishes the contexts, historical developments, terminologies and key research knowledge in the field. In addition, it reveals and classifies a wide selection of examples of prolonged product lifespans. This literature review addresses two key research questions:

Q1. What shapes the consumption and the obsolescence of products?

Q2. What can be learnt from existing examples of prolonged product lifespans?

In regard to question 1, it can be concluded that patterns of consumption and obsolescence are socially constructed. The complex interplay of 'relative' factors including sociological, psychological, technological and economic factors can cause obsolescence. In terms of consumer electronics, perceptions of technological change are key. For question 2, it was found that for many examples of prolonged lifespan arrangements are unplanned. They can be categorised into three groupings, Product (features), Individual user (behaviour) and Societal (socio/economic).

Part 2 of this thesis focuses upon addressing further research questions arising from the findings from the literature review.

Q3. Can specific examples of prolonged product lifespans be described and structured into formalised strategies?

Q4. Can product lifespan strategies be successfully applied to design projects?

In response to question 3, a selection of three strategies were identified, described and formalised as design strategies. [Refer to Chapter 7] The strategies, Piggybacking, Reassignment and Scripting satisfy selection criteria that; each strategy is representative of a range of issues discussed within this research, is relatively novel and unexplored in its potential as a means of mitigating product obsolescence.

For question 4, a pilot project was devised to assess the viability of the chosen strategies. It was concluded that the strategies, notably Piggybacking and Reassignment, could successfully be applied to design projects. The strategies were then aligned with design projects undertaken by the author. Whilst the Piggybacking (DABlife digital radio) and Reassignment (PSST! mobile phone breathalyser) projects produced the most complete and viable design outcomes, it was concluded by the expert evaluators that Scripting offered the most potential as a strategy to guide user behaviour. [Refer to Section 9.1]

Research question 5 is considered in Part 3 of this thesis.

Q5. Do product lifespans strategies offer opportunities for new design innovation to slow product obsolescence?

This question is reflective upon the findings from this research and relates directly to the aim of this research. Product lifespan strategies do offer opportunities for new design innovation. This is supported by expert evaluation of the author's own design projects. The Piggybacking project (DABlife digital radio) resulted in the design of novel product type that has significant commercial potential. Likewise the Reassignment (PSST! mobile phone breathalyser) project resulted in a resolved product form that also has commercial potential.

In addition, product lifespan strategies offer opportunities to slow product obsolescence. The strategies offer an example of 'adaptive design' which is explored in Section 9.2.4. Other new opportunities are identified based upon harnessing digital technologies such as rapid prototyping and networked products. [Refer to Chapter 9]

10.2_Limitations of research

The limitations of this research concern the validation of design strategies in accomplishing 'actual' prolonged product life, the 'value' mediated findings with the author's involvement in design projects and sample sizes for the student pilot project.

Dealing with each of these issues separately, the boundary of this research is limited to design practice through the application of specific strategies to prolong product lifespans. The likely success of each strategy and particular design project to 'actually' prolonging product life is not tested (quantified or measured) within this research. However, such knowledge would be useful in further validating the likely success of each strategy as applied to a particular product category. But this is unrealistic for various reasons. Primarily, as it would require longitudinal studies, over many years, tracking product life. Very few studies of this kind have been successful undertaken. Consequently, the reliance upon the use of surrogate indicators (such as product sales volumes and waste audits) are often relied upon to track product life.

Whilst the research method involving author's own design projects yields important findings, it also has its limitations. The process of 'creative reasoning' (Whiteley 2000: 23) by adopting research-through-design methods establishes that the author becomes 'involved' in what is being studied. Findings are thus 'transactional' mediated through the adopted 'constructive' epistemology. Where meaning is negotiated through the observer's engagement with what is being studied.

The sample size of students undertaking the pilot project was a further limiting factor. As a consequence, only one student chose the Piggybacking project and only two chose the Scripting project. Resulting in limited quality of design outcomes.

10.3_Further work

Current knowledge on many aspects of the lifespan of products is inadequate. Of the few empirical studies on product lifespans (Cooper and Mayers 2000; OECD 1982), there remains almost no study of actual product lifespans (Babbitt et al. 2009). This is particularly the case with the diversity of products that can be categorised as consumer electronics. There is still little known about the relationship between product lifespans and repair, upgrading and the role of secondary markets. Of the few initiatives that try to address product life, their

effectiveness remains inconclusive. It is within this wider imperative that further work is proposed to meet the challenges and opportunities for prolonging product lifespans. Recommendations for further work derived from this research address the following themes: building evidence, the role of design, adaptable open products and enabling technologies.

Empirical research on the declining lifespans of consumer electronics

The declining lifespan of many types of consumer products, especially consumer electronics, remains poorly understood. Empirical evidence remains scarce and few if any available studies track lifespan trends of specific product types (Cooper 2004). It is within this vacuum of data that environmental-management decisions are being made. Understanding product lifespans is fundamental to determining environmental impacts of a product. LCA is a commonly applied methodology (Tukker and Jansen 2006) used to quantify a product's lifecycle impacts. LCA methods make assumptions about product lifespan. Because of the lack of empirical data, product lifespans remains in many instances a 'best guess', and almost without exception, product life remains constant over time (Babbit et al. 2009) – despite evidence that lifespans in certain product sectors are contracting. Considering the importance placed on LCA and similar methodologies as a foundation for evidenced based environmental decision making, further empirical studies are needed to improve the accuracy of assumptions made about product life.

Widening the role of design

A shift is required to challenge the persistent view, still held by many design professionals, that the professional designers (as product shapers) determine the product value and that the user is essentially passive in his or her role of consumption. Theory and evidence from many fields suggests that users are also implicated in creating product value that can prolong product lifespans. Opportunities exist in formalising the cocreation of product value in a two-way traffic between the designer and user. This requires the design process to become more transparent to the user and enable redirective design processes (Fry 2009) that involve the user as a co-designer. This could partially be achieved by shifting industrial design away from technologically defined innovation towards user-centred innovation. The open-source movements and user-generated content providers that increasingly populate the internet offer a model of how this could achieved.

Adaptable open products

Professional designers should seek to stimulate creative opportunities for users to adapt and personalise products. This would require designers to intentionally create open products that are 'unfinished', and to be 'completed' by the user. Products configured in such a way can enable users to adapt a design to better meet changing circumstances. Products that are open to user adaptation are more likely to avoid obsolescence. Many instances of informal user-adaptation [Refer to Chapter 4] exist that can offer a foundation on which a formalised and strategic approach to creating 'open' products that can be adapted can be based.

Harnessing digital technologies

The internet and emergent digital technologies, such as rapid prototyping and manufacture, and wireless communications offer new opportunities to develop strategies to prolong product lifespans. A 3D rapid-prototyping printer could produce replacement or customised parts on demand in much the same way a desktop printer can print graphics and documents from a digital camera or computer. The pervasiveness of computing and the way it has migrated from wired-together desktop machines to handheld wireless devices illustrates how an 'internet of things' (Sterling 2005) is starting to emerge. Products connected to networks can offer opportunities to prolong product lifespans. Design has much to offer in exploring this potential by devising new strategies, hybrid product and service based business models in the rapidly evolving technological communications environment.

10.3.1_Future research

Clearly more work needs to be done in raising the importance of prolonging product lifespans - to legislators, industry, consumers and not least designers. To advance this imperative further empirical work needs to be undertaken to improve knowledge and quantify obsolescence in various product sectors. Further work is also required to understand consumer behaviour and attitudes towards product life. Such knowledge can better inform new design practices and further the development of strategies and directions such as those discussed in this research. [Refer to Section 9.5]

In regard to this research, a clear pathway for future work is to investigate the design of adaptive products. An adaptive product requires the designer to create a product that is intentionally 'unfinished' or 'open' to be completed by the user. The user then becomes a co-producer - in a two-way traffic between the designer and

user. Informally, such activities are already taking place with many websites and magazines offering amateur design enthusiasts tips on how to reassign, reconfigure and hack products and take control of their products. In the words of Makezine.com, "If you can't open it you don't own it." (Jalopy 2005: 154) In a strategic business setting this approach needs to be better-understood and formalised into structured design strategies.

10.4_Closing remarks

For design to engage with the task of slowing product obsolescence in our complex society and dynamic economy is challenging. The magnitude of interplay of socio/economic pressures can easily overwhelm any individual design response to extend product life. The design industry is also clearly implicated as a key actor in the construction of the promise of pleasures that incessant consumption can bring. Industrial designers are hired to construct such promises. For industrial design to disentangle itself from the worst excesses of unsustainable consumption, new strategies supported by new business models need to be developed and deployed.

It is argued throughout this research that design practices that influence product lifespans can occur both formally (courtesy of professional designers), and informally (courtesy of individual users). Designers often establish the circumstances within a product that can lead to obsolescence, while the user often determines actual product life. If a product can be adaptable for change circumstances, it is better able to avoid obsolescence. Industrial designers can enable user-adaptation of a product through the design of open products. An open product delegates a role of design to the user, thereby enabling a product to be adaptable to changing circumstances, prolonging its lifespan. Products that are reconfigurable to adapt changing circumstances are more likely to avoid obsolescence. Designing for prolonged product lifespans requires, as well as the traditional task of resolving the spatial dimensions of a product form, the design the temporal dimensions of a product. Both the professional and user designer become designers of space and time, designing the lifespan of products.

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Appendix

Appendix_1: The Australasian Institute of Backyard Studies. Guiding Principles for tinkering (Thomson 2008)

- Being a practical and useful person is a worthwhile achievement
- Encourage curiosity, wonder and other cheap thrills as the origins of imaginative problem solving.
- Useful and everyday things contain their own beauty.
- Without a grasp of the principles of mechanical advantage - the lever, the pulley, the screw, the inclined plane and wedge and the wheel and axle - we're stuffed.
- You can never have too many tools.
- I said put that down!
- A big mess in the shed or the backyard is only a problem for those without a clue.
- Don't throw that out - you'll need it one day, sonny jim.
- Reticence, mumbling and disorganisation are the signs of a deep and enquiring mind.
- Good ideas are precious beyond rubies but if not shared freely are as useless as tits on a bull.
- And leave something for the next bloke.

Make Magazine's: The Maker's Bill of Rights

- Meaningful and specific parts lists shall be included.
- Cases shall be easy to open.
- Batteries should be replaceable.
- Special tools are allowed only for darn good reasons.
- Profiting by selling expensive special tools is wrong and not making special tools available is even worse.
- Torx is OK; tamperproof is rarely OK.
- Components, not entire sub-assemblies, shall be replaceable.
- Consumables, like fuses and filters, shall be easy to access.
- Circuit boards shall be commented.
- Power from USB is good; power from proprietary power adapters is bad.
- Standard connecters shall have pinouts defined.
- If it snaps shut, it shall snap open. Screws better than glues.
- Docs and drivers shall have permalinks and shall reside for all perpetuity at archive.org.
- Ease of repair shall be a design ideal, not an afterthought.
- Metric or standard, not both.
- Schematics shall be included.

Appendix_2: Distinguishing qualities of research and practice

(adapted from Cross cited in Pedgley and Wormald 2007: 75 and Durling 2006)

Research is	Practice is
• Systematic investigations and enquiry into ... • Research asks questions • Selects appropriate methods • Transparent and documented • Analysis and discovery • Generates new theories • Takes risk • Tells others what to do • Findings are public • An enduring record • Locatable and searchable	• Application of professional skills in designing • Practice can be routine • Sometimes it pushes boundaries • Learning through experience • Often what is called research is information gathering

Appendix_3: Eco-design principles: Design Edge (1994)[1]

Design for Long life	A durable product markets quality, consistency and reputation for the manufacturer. In the long term this reduces the consumption of raw materials and the associated energy sue and pollution caused.
Appropriate Choice of Materials	The selection of material minimises environmental impact in processing, use and disposal does not necessarily result in cost and performance penalties
Minimise Material Quality	Energy used and pollution caused in manufacture is reduced by minimising material quantity. An added advantage is savings in product cost.
Minimise Variety of Materials	Minimising the variety of materials within one product makers recycling easier and can also produce product cost savings
Minimise Number of Components	Reducing the number of components by extending component function facilitates assembly and recycling with associated cost benefits
Design for Disassembly	Rapid and simple disassembly improves ease of resue, repair and recycling. This strategy also reduces cost in assembly by minimising labour and, often, investment in dedicated machinery.

[1] The Author, an employee of Design Edge at the time, was a contributor to the drafting of these principles.

Appendix 4: Design | Behaviour Poster

Sustainable Design Network

design | behaviour

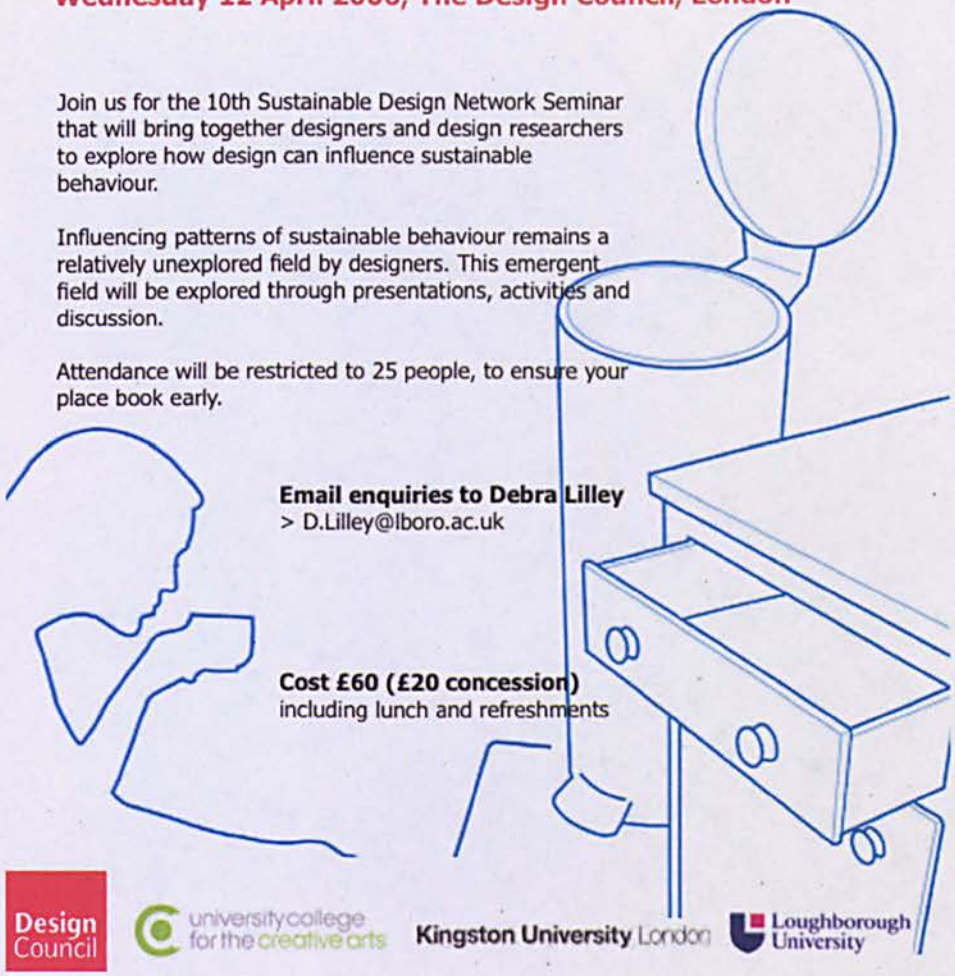
The Sustainable Design Network invites you to
a special one day seminar

Wednesday 12 April 2006, The Design Council, London

Join us for the 10th Sustainable Design Network Seminar that will bring together designers and design researchers to explore how design can influence sustainable behaviour.

Influencing patterns of sustainable behaviour remains a relatively unexplored field by designers. This emergent field will be explored through presentations, activities and discussion.

Attendance will be restricted to 25 people, to ensure your place book early.



Email enquiries to Debra Lilley
> D.Lilley@lboro.ac.uk

Cost £60 (£20 concession)
including lunch and refreshments

Design Council

university college for the creative arts

Kingston University London

Loughborough University

Appendix 5: Design | Behaviour event agenda

The Design Council, London, Wednesday 12th April 2006

9.30	Morning tea and coffee
10.00	Introduction, Tracy Bhamra, Sustainable Design Network.
10.30	Tim Dant, University of East Anglia, "Materiality and Morality"
11.00	Lynne Elvins and Rupert Bassett, A420, "Sustainability Issue Mapping; Making Sustainability Personal"
11.30	Richard Miles, Loughborough University, "Case study 1: Designing Behavioural Change: Reprogramming the User"
12.00	Lunch
1.00	Guy Robinson & Robert Brown, Sprout Design. "Case study 2: Understanding Behaviour for Successful Product Development"
1.30	Design activities Parallel session 1: 'Designing behaviour' Parallel session 2: 'Using & consuming'
3.00	Coffee
3.30	'Provocations': Group discussions and feedback
5.00	Close and coffee

Appendix 6: Product Obsolescence Key

A product may become obsolete for one or more reasons:

- Functional obsolescence (product failure or diminished performance)
- Technological obsolescence
- Economic (uneconomical to repair, upgrade or inefficient to operate)
- Regulations (unsafe, toxic or banned substances)
- Social change (irrelevant or socially unacceptable)
- Fashion obsolescence
- Aesthetic obsolescence (Wear and tear)
- Change of lifestyle/circumstance (unwanted, unneeded)

Appendix 7: Using and Consuming Outcomes for each product.

design | behaviour

Workshop 1 - Using & Consuming

The Product Candidates


car stereo


hair clippers


3 ½" disks


iron


Lego kit


mobile phone


portable radio

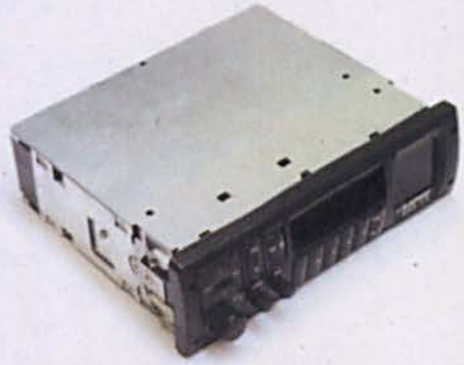
Car Stereo

Task 1_Role of user

Assume the role of the **User**, the owner of this product.

- *Determine the reason(s) for obsolescence. [See Product Obsolescence Prompts for prompts].*
- *What would be your behaviour in response to the reason(s) for obsolescence?*
- *What are your options?*

Be realistic about your actions and options available.



User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional obsolescence		
Technological obsolescence	Replace with electrical version	Display as "Retro" hair clippers
	Keep for occassional use	Re-use occasionally when hair grows too long
	Sell	Sell on e-bay, car boot sale or give to charity shop
	Keep the box	Re-use for its retro styling
Economic		

Regulations		
Social Change	People increasingly visit hairdressers	Choose hairdresser
Fashion obsolescence		
Aesthetic obsolescence		
Change of lifestyle/circumstance		

Task 2_Role of designer

Assuming the role of the **Designer.**

- *How would you re-design this product?*
- *How would you design "out or in" behaviour around the identified issues of product obsolescence?*

Think also beyond the product, you could propose new business models or product service systems.

Using the supplied A2 paper, document your redesign proposal. You could sketch it, do a mind map, flow chart, specification list, etc.

Designer response	
1. Hardware system upgrades *or*	
2. MBox MBox is a portable stereo that will fit any make of vehicle. It is connected to upgrades and data via satellite so it will never go out of date. An interchangeable cover means it can be aesthetically updated.	

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- *What are your options?*

Be realistic about your actions and options available.

User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional obsolescence		
Technological obsolescence	Keep them for a while in the hope of finding a way to recycle them.	KeepRecycle
	Keep them for fear of loosing data till next generation back-up.	Discard
Economic		
Regulations		
Social Change		

Fashion obsolescence		
Aesthetic obsolescence		
Change of lifestyle/circumstance		

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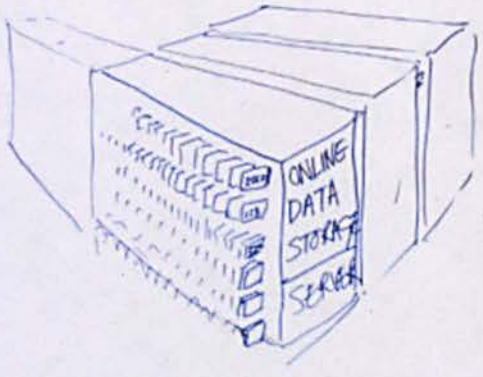
Designer response	
All data is held in an on-line, central bank thereby eliminating the individual need for disks. When the system needs upgrading, all materials can be easily collected and reused/recycled.	

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Hair Clippers

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- *What are your options?*

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User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional obsolescence	Replace the broken spring with the one provided in the box	Throw away or repair. Disassemble for recycling.
Technological obsolescence	Buy a newer electrical version	Keep for occassional use. Keep this retro object for display. Sell on e-bay, car boot sale or charity shop
	Attracted to box styling despite age	Keep for re-use

Economic		
Regulations		
Social Change	Go to hair dresser for ease and aesthetic concerns	Choose hairdresser
Fashion obsolescence	Attracted to retro styling	
Aesthetic obsolescence		
Change of lifestyle/circumstance		

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Designer response	
Clippers with character Functionality is increased, whilst giving the clippers character, Alessi style. The clippers are used by barbers, making them part of a product service system and reducing the environmental impact of the product. In this way they increase social interaction and jobs too!	

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User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional obsolescence	Replace the broken cord/plug Descale	Throw away and buy new iron Repair Store at back of cupboard Take to a specialist (charity?) repair shop Take to a charity shop
Technological obsolescence	Less need to iron due to 'creaseless' fabrics	Buy 'creaseless' clothing fabrics

Economic		
Regulations		
Social Change	Ironing less at home	Employ someone to iron/laundrette services Iron less Continue ironing
Fashion obsolescence	Replace old, 80s looking iron	Pass on to children as they move out
Aesthetic obsolescence		
Change of lifestyle/circumstance		

Task 2_Role of designer

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Designer response	
Multiservice This solution proposes a simple service and capitalises on existing behaviours. A laundrette business that offers: 1. Conventional laundrette service of washing, drying and ironing clothes. 2. Iron rental (for an evening or more) 3. Repair: resurfacing, electrical checks, preventative action 4. Ironing pick-up & delivery service.	

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- *What are your options?*

Be realistic about your actions and options available.

User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional obsolescence (due to loss of pieces)	Reuse other pieces and make an alternative model	Tip into the box with all other pieces Throw away or recycle Get a new/replacement piece
Technological obsolescence	Sell on e-bay	Store in cupboard/loft Sell or give away Throw away or recycle Replace with a new version

Economic		
Regulations	Throw away or recycle if (safe/viable)	Plastics degrade Regulations change Throw away or recycle
Social Change		
Fashion obsolescence	Favour other toys	Store in cupboard/loft
Aesthetic obsolescence	Believe the Lego needs replacing	Throw away or recycle Replace with new
Change of lifestyle/circumstance	Retain for the future	Store in cupboard/loft Sell or give away Throw away or recycle

Task 2_Role of designer

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Using the supplied A2 paper, document your redesign proposal. You could sketch it, do a mind map, flow chart, specification list, etc.

Designer response	
Various design strategies offered: **1. Replacement pieces** • Sell 2 complete sets in a box • Suggest alternative models to make with fewer pieces	

with fewer pieces

- Fewer specific pieces
- Introduce glue/permanent assembly
- Sell 3D printer so users can make their own replacement parts

2. Lego part exchange scheme

- Lego exchange website - a pieces swapshop or sale site
- Sharing new and original designs
- Packaging promotes exchange and passing-on

3. Re-use

- Lego pieces are designed to allow building into teenage/adult objects e.g. office chair or plant pot

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Mobile Phone

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- *What are your options?*

Be realistic about your actions and options available.

User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional & Technological obsolescence	Ask contract provider for a new phone Trade in old phone (e.g. for £10 off a new phone)	Keep in drawer as an emergency phone or for situations where a new phone may get damaged Put in 'reuse/recycling' bin at shop Use as children's toy Use as door prop Give away to developing world Use for model-making/jewelery

		Sell on e-bay etc
Economic		
Regulations.		
Social Change		
Fashion obsolescence		
Aesthetic obsolescence		
Change of lifestyle/circumstance		

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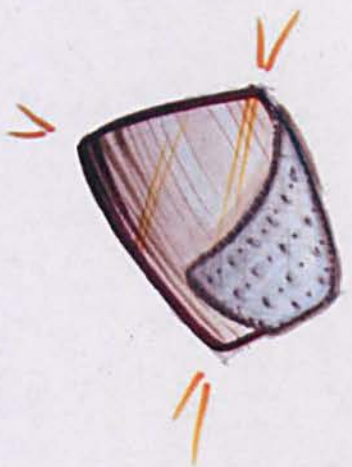
Using the supplied A2 paper, document your redesign proposal. You could sketch it, do a mind map, flow chart, specification list, etc.

Designer response	
Various design strategies offered: **1. Common Parts for modular add-ons** • Exchange available via shops to swap for MP3 player etc **2. Exquisite phone** • Replace the desire for more functions with pleasure at the exquisiteness of the object e.g. wooden with silk crochet panels	

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Portable Radio

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- *What are your options?*

Be realistic about your actions and options available.

User response		
Obsolescence Factor	**User Behaviour**	**Options**
Functional obsolescence		
Technological obsolescence	Replace	Give old radio to Oxfam Buy a digital radio
Economic		
Regulations		
Social Change		
Fashion obsolescence		

Aesthetic obsolescence	Clean the paint off Relocate	Cleaning may be limited and may affect plastic Put in the shed or attach to a bicycle
Change of lifestyle/circumstance		

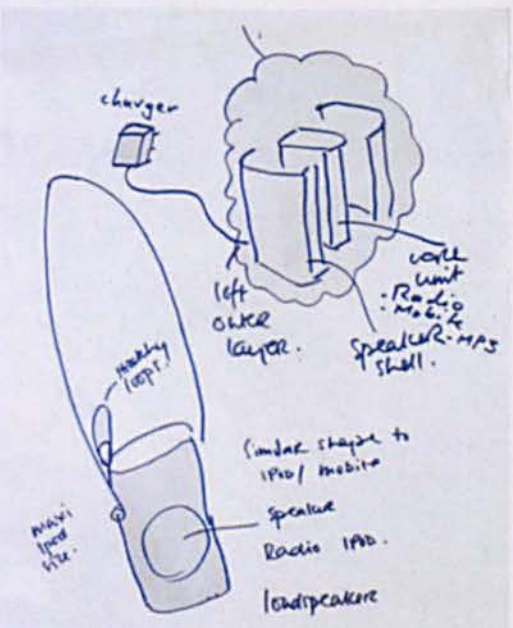
Task 2_Role of designer

Assuming the role of the **Designer.**

- *How would you re-design this product?*
- *How would you design "out or in" behaviour around the identified issues of product obsolescence?*

Think also beyond the product, you could propose new business models or product service systems.

Using the supplied A2 paper, document your redesign proposal. You could sketch it, do a mind map, flow chart, specification list, etc.

Designer response	
This solar-powered radio combines phone and radio and has similar functions to the iPod. A protective, washable shell also acts as detachable speakers.	

Appendix 8: Design project evaluation comments

Piggybacking: DABlife DAB radio

Do you believe that this project successfully demonstrates the application of the proposed strategy of Piggybacking? In other words – does the strategy make sense?
Comments: The strategy makes sense and represents a sophisticated view of defining 'durability' and product life extension. Piggybacking has the potential to maximise primary product longevity by extended functionality to keep pace with technological developments. Piggybacking helps to directly reduce the risk of premature obsolescence by intelligent 'technical add-ons' that would be seen as desirable and acceptable by many in the market. Piggybacking has the potential to maintain and enhance some brand loyalty by having the manufacturer of the primary product (the radio), also produce the DAB unit thus providing a post-consumption or after-market type service offering. Worthy of exploring IP issues for commercialisation

Can you think of other products that could benefit from this strategy
Comment The general concept has application across diverse product categories, however product types directly and indirectly affected by rapid technological and software based changes and cycles would be the most obvious beneficiaries eg. the transition from analogue to digital. In a more mechanical sense, there may a range of products whose primary function can be exploited to perform other tasks and functions eg. torches, lights and lamps that have special lenses and filters that perform non-illuminating tasks; combustion engine based lawn mowers and garden tools that have add-ons which perform non-grass cutting functions; everyday bicycles that have add-ons which can deliver human powered tasks related to clothes and dishwashing; energy generation; air-blowing/vacuuming etc etc. The list would be considerable. Similar solution as applied to 'set-top' digital TV boxes.

Can you suggest improvements, shortcomings, oversights or other things to consider?
General comments Nothing obvious at this stage. The concept is positively noteworthy in its current form. Subject to market factors and pricing, the issue of aesthetics and visual compatibility may require diverse or multiple responses. While some consumers will demand the function, other will want function and an add-on unit that looks seamless or appropriate. In other words, think about whether the add-on unit needs a Dick Smith Electronics (Argos or Dixons UK) design approach, or a Bose or B&O design approach .... or all of the above. Food for thought.

Reassignment: Psst! Mobile phone - Alcohol breathalyser

Do you believe that this project successfully demonstrates the application of the proposed strategy of Reassignment? In other words – does the strategy make sense?
Comments: Yes perfect sense where the interface between the products is widely available, ideally universal. Unfortunately, for example mobile phone connectors are currently brand specific and not universal, although I read somewhere that more commonality in mobile connectors is a likely in the future. Using old computer or products such as mobiles as an 'engine' for other products is a good idea. I believe Nokia recently released IP to allow other manufacturers precisely to allow 'reassignment' of Nokia products, for development into new processes. Eg. Using old mobiles to drive a security camera, Using old mobiles to automatic transfer of data – eg. vending machines. This concept has significant merit, especially given the volume of discarded and/or redundant mobile phones in the market. Reassignment has the potential to extend core product life by offering a new function which is personally and socially responsible and contributes to general personal safety and human health. Extended core product life through the breathalyser unit also helps to transform an product which ash effectively become semi-disposable into a device that has indefinite ongoing use and can sit in the glove box of a care. It is unlikely that the reassignment performance and functionality will be affected by any rapid technological advances that render the reassignment functions useless. Some re-calibration may be required over time if drink driving levels change however such modifications would be straightforward to incorporate or program.

Can you think of other products that could benefit from this strategy
Comment Mobiles are great for this strategy because they are produced in such large volumes, small, have on-board CPU, memory & screen. Many of the comments noted under 'piggybacking' may also be relevant here. I believe one method for identifying other products might be to closely analyse and understand the post-consumer waste stream. This would highlight a range of products and/or components that might be successful candidates for reassignment. An obvious broad category to consider would be the growing volume of consumables which result from business imaging and other electrical and electronic devices i.e. how could toner cartridges, drums, inkjet cartridges be reutilised to other ends. The auto service and repair industry also generates products and components that may be suitable eg. tyres, oil filters etc. How might these be reassigned?

Can you suggest improvements, shortcomings, oversights or other things to consider?
General comments This may be more difficult for physically larger products. The new product may be severely restricted due to the obsolescence and paucity of the 'mothership' product. This is probably a minority market strategy. ie. Few major manufacturers would base a new business model on the availability of a specialised 'waste' stream product with reducing supply. A definitional query emerges in relation to this concept. How different to 'refurbishment' and/or 'reuse' is reassignment? Is it recoding of an existing product sustainability strategy or is it something fundamentally different? Indeed is the question of difference or overlap relevant or critical anyway. I believe the concept of reassignment needs to be considered as part of a more sophisticated hierarchy European Union a new way of approaching the waste management hierarchy that reflects product

sustainability in a smart and more commercially realistic manner. Maybe the time has come to move from 'reduce, reuse and recycle' to a more advanced model that more effectively reflects life cycle thinking, business opportunity and overall socio-environmental benefit, including the role of behaviour change and outcomes that support and enable everyday sustainable consumption. Perfect conditions to consider 'reassignment, repurposing (as per carpet sector) and remarketing (as per IT sector). These are driven by market benefit, user need and commercial gain .... While also delivering meaningful materials efficiency and environmental benefit.

In short, I think the 'reassignment' concept has significant value in some product categories as linked to post-consumer product opportunities. Mobile phones is a strong starting point for elaborating the model.

Scripting: Laptop computer

Do you believe that this project successfully demonstrates the application of the proposed strategy of Scripting? In other words – does the strategy make sense?
Comments: The scripting philosophy makes good sense in several business areas. In some areas upgradable components, software and user changeable, use defined components work very well. Eg. Some mobile phone covers allow, replacement for fashion, added technology (eg games phone covers), printable, 'photo' display. Restraining forces regarding the concept include perceptions of high gloss surfaces. Scripting is an extremely worthwhile concept and extends the role, purpose and value of the humble 'instruction manual' or service guide .... documents which are generally not read or kept by the majority of consumers. The idea of an 'onboard toolkit' is wonderfully refreshing and demonstrates an understanding of user-friendliness and how to achieve it against the odds. Strategies that enable and facilitate effective, efficient and no cost/low cost user maintenance, repair, cleaning etc, are strategies that are timely i.e. economically sensible, socially desirable and ecological necessary. Product life extension that is enabled through scripting makes sense and also motivates a more informed user – object interface or relationship. Effective service and maintenance of products nearly always extend product life and/or maximise product functionality, reliability, safety and performance. A strategy such as scripting that helps to achieve such outcomes is significant and should be further developed, refined and advocated ... from the design stage and among brandowners. Scripting needs to be regulated in many respects to ensure industry wide participation , as is required for energy labelling and toxics content eg. European Union EuP and European Union RoHS directives ... as a well as a million other product labelling requirements around the world, many of them driven by safety.

Can you think of other products that could benefit from this strategy
Comment Products which have a very personal user interface. Modular products. Products which have intrinsically long life spans, and /or elements of fashion, tactility & wear in use. Eg. Furniture. (Formway LIFE chair is quite good example of this – v. easy to reupholster and with several user configurations) Also products with local market connections. Or products which can be visualised and personalised and purchased on-line. Eg. Blend your own muesli. YES, The vast majority of manufactured goods!!!!!!!! Scripting is a great idea. I regard the 'onboard toolkit' element as significant, innovative and very practical. The design of vacuum cleaners in recent years has successfully exploited the onboard feature quite well, as have car manufacturers for many years. Has some relevance and connections to the concept of the 'picnic basket of the future' i.e. the autonomous

kitchen featuring all the bits and bobs you might need while lunching in the wilderness.

Can you suggest improvements, shortcomings, oversights or other things to consider?

General comments

One of the key things to consider is the politics of labelling and standards and how these play out in the design, manufacture and distribution of goods. Industry clichés set up to develop and agree on such matters and they generally fear and oppose too much product labelling and information. Thus, the need to regulate for such socially and environmentally beneficial outcomes would be worthwhile and necessary to capture recalcitrant producers.

I believe the smarter, more design oriented companies who value user input and consumer friendlieness are maybe considering such concepts. In short, any strategy that can redefine the 'instruction manual' into a knowledge and guidance resource that is actually used by consumers, is a strategy that deserves attention .... and Nobel prize.

Which project do you think is the most successful and has the most potential in prolonging the life-span of consumer electronic products?

Piggybacking	Good applicability in niche-areas; commercial potential; Gold
Reassignment	Potential – but in niche-areas; Gold
Scripting	Most applicable; Gold plus plus

Comment

I don't believe there is a single winner as such. Maybe. Possibly . All gold medals!! Each has a role and place depending on market, geography, post-consumer opportunities etc.

For example:

- it may be that piggybacking has strengths and value in developing countries;
- it may be that reassignment has potential in boozy cultures where drinking heavily and pranging cars is the norm i.e. Scotland and Australia!!!
- It may be that scripting works more effectively where there are products with potentially short life spans that could be extended if user guidance is bolstered etc.

If I had to pick one based on current thinking and information, I believe that scripting has potential and value across all product types ... in addition to consumer electronics. User friendly instructions, onboard toolkits, spares, cleaning advice etc etc ... is a positive life extender in all product categories.