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DESIGN FOR SUSTAINABLE BEHAVIOUR: A QUICK FIX FOR SLOWER CONSUMPTION?

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Abstract

The continuous replacement of durable consumer goods and disposal of functioning or repairable products into UK landfills or, increasingly, to developing countries, has resulted in global environmental and social consequences. Small appliances, which are easily disposed of in household waste, typically end up in UK landfills, are shipped to developing countries or otherwise 'lost'. Very few are recycled or repaired, yet many are still functioning when disposed of. Consumers' willingness, opportunity and ability to carry out repairs have historically been hampered by a range of complex factors. Design for Sustainable Behaviour (DfSB) aims to reduce the environmental and social impacts of products by moderating users' interaction with them. This paper explores how DfSB strategies can be used to encourage a behavioural shift towards repair of small electrical household appliances by overcoming identified barriers. The paper pulls together literature on repair practice, highlighting gaps in current knowledge and outlines the findings of an extensive UK household survey focused on both product breakage rates and consumer mending behaviour. Three mending typologies and associated personas resulting from the analysis are combined with three DfSB strategies to develop conceptual design interventions to encourage repair. The paper concludes with a discussion of the potential efficacy of the design outcomes from a consumer perspective and the potential ramifications for design practice, whilst considering the wider influences on repair practices beyond design and how these may be addressed.

Keywords

Design, Behaviour, Product, Lifespans, Repair

1. Introduction

Rapid turnover in consumer electronics, fuelled by increased consumption, has resulted in negative global environmental and social consequences. Small appliances, which are easily disposed of in households waste, typically end up in UK landfills or developing countries or otherwise 'lost' (DEFRA, 2011; Basel Action Network, 2011; AMDEA, 2011) very few are recycled (Darby and Obara, 2005¹) or repaired. Indeed, independent testing of 112 WEEE items in 2011 found that "12% of WEEE at HWRCs [Household Waste Recycling Centres] was in full working order" when disposed of (WRAP, 2011). This suggests that appliances are rarely discarded as a result of diminished capacity to function but for other, more complex reasons.

To reduce mounting electronic waste (e-waste), consumers must be encouraged to retain their devices for longer. Repair has been recognised by industry and academia as a viable option for diverting and/or recovering materials from the waste stream (Cooper, 2010; ERM, 2011; Brook Lyndhurst, 2010), yet "Design for repair" (Van Nes, 2010), is under-researched. Concurrently, consumers' willingness, opportunity and ability to carry out repairs have historically been hampered by a range of complex factors, summarised in Table 1 below.

Factors influencing repair	Literature sources
Manufacturers employ strategies to deliberately limit the functional life of a product, reducing the time between buying and replacing it. This curtailment, known as ' <i>Planned Obsolescence</i> ' is typically enacted with the intention to increase sales and maximise profit through continuous turnover. ' <i>Design for limited repair</i> ', arguably a sub-set of planned obsolescence, discontinuing production of replacement parts making it impossible to repair or reinvigorate older products or phasing out after-sales support can also drive premature disposal and replacement of functioning products, as can altering the system in which the product is used or introducing new software/parts which are incompatible e.g. Windows Vista.	<i>Cooper, 2010</i> <i>McCullough, 2007 in:</i> <i>Guiltinan, 2009</i>
Product design which actively (or passively) prohibits or curtails users ability to enact repairs through increased electronics; sealed sub-assemblies protected by tamper-proof, hidden fastenings; rubber,	<i>Park, 2010</i> <i>McCullough, 2009</i> <i>Chismar, 2008</i>

¹ Of nearly 5,000 households surveyed in Cardiff, Wales in 2003, 97% of small electrical goods were not recycled, with the majority being disposed of via CA [Civic Amenity] sites (33%) or in the household refuse (26%)

plastic or metal shells which sustain damage when forced; and the concealment of internal mechanisms.	
Widespread reductions in retail prices for household consumer products coupled with the cost of repair relative to the cost of replacement, limited time to investigate repair options, price slashing and discounts, shorter warranties and a lack of repair outlets and available technicians typically results in affluent households disposing of and replacing products rather than repairing them	<i>Cooper, 2010</i> <i>Gultinan, 2010</i> <i>McCollough, 2009</i>
Goods failing or breaking outside of the statutory guarantee period and the lack of take up in warranty or extended warranty purchase due, in part, to households with reduced income preferring to focus on meeting their more immediate fiscal needs. Thus products which break outside of the guarantee or warranty period are discarded rather than repaired.	<i>Cooper and Christer, 2010</i> <i>Twigg-Flesner, 2010</i> <i>Utaka, 2006</i>
The long term sustainability and viability of providing after-sales service is affected by costs borne by the company or passed on to the customer (e.g. call out charges, labour and parts), facilities and infrastructure for processing repairs, the skills and knowledge required in the workforce to repair and maintain older products.	<i>Twigg-Flesner, 2010</i> <i>McCollough, 2009</i> <i>Klausner et al., 1999</i>
Customer's lack of confidence in the repairer, their perception of what constitutes a 'fair price' and concerns over being exploited by unscrupulous repairers who overcharge, over-service or charge for fictitious repairs which were never carried out.	<i>Which? 2011</i>
Lack of knowledge, skills and information coupled with an inability to understand devices and diagnose problems due to information contained in service manuals being either too simple (crude schematics and trouble-shooting advice) or, conversely, written using highly technical terminology which is at best unfamiliar, at worst incomprehensible, to the layman.	<i>McCollough, 2009</i> <i>Chismar, 2008</i>

Table 1: Factors influencing repair derived from literature review

The factors outlined in Table 1, tend to be reported in the literature as homogenous and have yet to be disaggregated to reflect individual repair decisions for different customer segments. Furthermore, the extent to which these factors impact on repair decisions is currently unknown. To augment and deepen current understanding of the factors which influence repair practices, typical faults of small household appliances and decision-action paths enacted by consumers in response to product breakages, an extensive on-line survey of 158 UK Householders was conducted which aimed to gather further insights into contributing factors which influence repair practices. To investigate the opportunities for

design, and specifically design for sustainable behavior, to intervene and create behavioural change, a further two research stages were undertaken; design ideation workshops in which designers applied theory to design for repair for different self-mending typologies (derived from the survey findings) and a user evaluation of the conceptual designs produced. The remainder of this paper introduces the methods employed within these studies in greater depth and discusses the findings of each of the three stages of research in turn. It concludes with a discussion of the potential efficacy of the design outcomes from a consumer perspective and the potential ramifications for design practice, whilst considering the wider influences on repair practices beyond design and how these may be addressed.

2. Methodology

Three different stages of data collection were undertaken in order to understand the opportunities for applying design for sustainable behavior to encourage self-repair and slow consumption. An extensive on-line survey which resulted in an understanding of contributing factors which influence customer-led repair practices and a mending typology, design ideation workshops in which designers applied theory to design for repair for these typologies and a user evaluation.

2.1. Extensive on-line survey

An on-line survey was chosen as it enabled the researchers to gain a high volume of data in a relatively short period of time in a standardised format to enable systematic capture of quantitative and qualitative data (Robson, 2002). The survey contained open and closed questions in an attempt to enrich the quantitative data with qualitative data, using intra-method mixing to triangulate data and improve its quality (Tashakkori and Teddlie, 2003).

The focus of the research was on small electrical household products, as detailed in Table 2. These were considered logical candidates for repair as, with the exception of Personal Entertainment Products, their aesthetic value is low but functional value high, they are rarely replaced prematurely (as little increase in functionality, utility or aesthetic can reasonably be anticipated), expected to last until broken and often kept until failure. Furthermore their circuitry is fairly simple and could be easily repaired with little technical skill if their inner workings were made accessible.

Kitchen Appliances	Personal Care Appliances	Personal Entertainment Products	General Household Appliances	Tools
Kettle Toaster Coffee Maker Food Processor Electric Juicer Electric Steamer Electronic Kitchen Scales Electric Whisk	Hairdryer Hair Straighteners Electric Razor Electric Toothbrush Bathroom Scales	MP3 Player Gaming Device Laptop Mobile Phone E-reader Digital Camera	Radio Sat- Nav Landline Phone Clock Fan Lamp	Electric Screwdriver Electric Drill Electric Sander Circular Saw Jigsaw

Table 2: Small household products included in the household survey

Demographics and lifestyle questions were asked before respondents indicated their prevailing behaviour towards self-repair of products. This order was chosen to limit the impact of the self-repair behaviour question on the more subjective answers previously given (Bertrand and Mullainathan, 2001). Different answers to the self-repair behaviour question (e.g. 'Products have broken and I have attempted repairs on all of them myself', 'Products have broken and I have not attempted repairs') led the respondent to different sections of the questionnaire in order to capture experiences relevant to them.

The survey was distributed through using a 'snowball technique'. A limitation of this technique is that the demographic spread of respondents cannot be controlled, thus interested groups are likely to be over-represented (Robson 2002); in this case the propensity to mend shown by respondents may be over-estimated, although this approach did allow for numerous responses fulfilling one of the main aims of this research; understanding mending experiences. A further limitation of the data collection is that ethnicity data was not collected; therefore different mending cultures associated with different ethnicities could not be assessed. Finally the product lifespan responses obtained were self-reported, based on the recollection of respondents, and therefore may not be entirely accurate.

158 complete responses to the online extensive survey were obtained. The survey data was analysed to establish overall breakage rates for the range of small electrical household products, participant's views of actual and expected lifetimes for the most commonly broken product in each product sub category, participant's different self-mending behaviour

typologies, socio demographic and lifestyle indicators associated with these different typologies and barriers and enablers to repair for different typologies.

2.2. Design Workshop

To drive design ideation and test the potential application of a Design for Sustainable Behaviour approach to the issue of designing for repair the findings of the survey needed to be translated into inspirational material for designers to engage with. The three typologies derived from the survey data regarding demographic breakdown, lifestyles, attitudes and barriers and enablers to repair (as summarised in Table 4) were, therefore, developed into archetypal personas which enabled the designers to target the specific needs and attitudes of each typology. Personas represent a class or type of user, how these users behave, how they think, what they want to accomplish and the underlying reasons which inform these decisions (Pruitt and Adlin, 2006) and were, therefore, considered useful as they provide a “conduit for conveying a broad range of qualitative and quantitative data, and focus attention on aspects of design and use that other methods do not” (ibid, p1). Having established personas for mending typologies, these were compared to the DfSB strategies depicted on the ‘axis of influence’ (Figure 2). The different self-mending behaviours, socio- demographic and lifestyle indicators and barriers and enablers to repair for each of the three main typologies were evaluated against the three levels of intervention to ascribe a mending typology to a DfSB strategy. Fixers do not lack motivation to mend, but instead their barriers to mending are focused at the user end of the DfSB spectrum, where the product or offering provides information and guides changes. Conversely, Non-fixers (and extreme Non-fixers) are likely to require interventions to ensure change, at the product end of the DfSB spectrum through employing persuasive methods and technologies to change what they do, as they lack the personal motivation to mend. As with much of this research, the Sometimers appear to sit at the mid-point of the DfSB spectrum, where the intervention seeks to encourage more mending behaviour through the product providing embedded affordances and constraints to help unblock the main barrier to mending, where the consumer is unsure of what the problem with the product is.

The archetypal personas, aligned with appropriate DfSB strategies, were used to drive design development in workshops that aimed to produce conceptual interventions which encourage an increase in self-mending behaviours for Sometimers and Non-fixers, and reduce challenges to mending for Fixers. Kettles, the most commonly reported broken household appliance by survey respondents (53% of respondents), were chosen as the focus. A group of eight masters-level design students and academics with expertise in new product design and sustainable design were briefed on the findings of the literature review,

extensive survey and the DfSB framework (Figure 2) as well as the archetypal personas (Table 4). The workshop consisted of three separate half hour brainstorming sessions, where the eight participants were split into three teams and rotated around the three personas. Participants were instructed as to the alignment of personas with different points of the DfSB spectrum. After each rotation, the groups were asked to share their ideas to enable subsequent groups to build on ideas already formulated. Visual thinking techniques were adopted during the sessions to help expand the quantity and quality of ideas, and capture a visual output (Roam, 2009). This involved participants using the persona information supplied and imagining and sketching new product ideas that would both satisfy the preferences of the individual personas as well as reflect the intervention level assigned for that persona from the DfSB spectrum.

2.3. Evaluation by Typology Users

There is a great deal of potential for customer-led repair to slow the throughput of material resources through extending product lifespans and reducing premature disposal of functioning appliances. The argument of whether design for repair is technically feasible and practically achievable is not core to the debate. The capability is present; the questions reside within the desirability of repairable products from a customer perspective. To evaluate the concepts generated and explore the extent to which they would encourage self-repair attempts for each typology, semi-structured interviews were carried out with three individuals from each typology identified. The sample was self-selected via a follow-up participation tick box added to the extensive survey and were selected to represent an equal number of participants classified as each of the three typologies.

Interviewees were shown concept images and descriptions of the eight consolidated ideas generated (Table 5). Whilst the typology of the interviewee was known (from the survey response) the interviewees were not told which concept was aimed at which typology, and the concepts were shown in a random order. Interviewees were asked to rank the concepts in order of the degree to which the concepts would encourage them as an individual to attempt repairs should their kettle break. The information regarding the target typology was withheld to establish the extent to which concepts generated for different typologies at different points of the DfSB spectrum were attractive to that target typology. For their top three selections, interviewees were then asked to discuss what aspects of the concepts would encourage them to undertake repairs (to ensure the intended DfSB intervention was the feature that encouraged repair), how likely they would be to purchase the kettle were it commercially available (to judge the potential for the concept becoming a credible product),

and how much more, when compared to a standard kettle, they would be willing to pay (to judge whether monetary value was added by the DfSB intervention).

3. Summarised Findings of Extensive Survey

The following sections detail findings related to overall breakage rates and actual and expected lifespans as well as introducing a typology of mending which emerged from the data.

3.1. Overall Breakage Rates

Within the 158 completed responses to the survey, it was found that 616 items within the broad category of small household electrical appliances had broken in the last 5 years, equating to 3.9 broken items per respondent on average. Only 5 responses noted no products had broken in this category over the relevant time period. The most common sub-category of broken products was Kitchen Appliances (36% of all broken products), followed by Personal Entertainment products (32%), Personal Care products (15%), General Household electrical appliances (11%) and Tools (5%). Looking across all of the broken products reported the most common were: kettles (53% of respondents), laptops (44% of respondents), mobile phones (34% of respondents) and toasters (31% of respondents).

3.2. Actual and Expected Lifespans

Respondents were asked to give information about the actual lifetime of their broken product, and also what their expectations of lifetime for the product were. Whilst expected lifetimes for all sub-categories were higher than actual life times, there were differences in the values between product sub-categories. Within kitchen appliance, the actual lifespan (mean) was only 4 years compared to an expected lifespan (mean) of 6 years. The personal care appliances segment was consistent with kitchen appliances scoring 4 and 6 for actual lifespan and expected lifespan respectively. Personal entertainment products on average lasted only 3 years, but were expected to last 5. General household appliances and Tools lasted the longest at 5 years on average, and both categories were expected to last 8 years.

Figure 1 below shows the most commonly reported broken products in each category and their actual and expected lifetime. The differences in actual and expected lifetime of the most commonly reported broken items were not always reflective of the sub-category averages, with the differences being most marked for Landline phones (General Household Appliances) (3.1 years), Kettles (2.4 years) and Laptops (2.1 years).

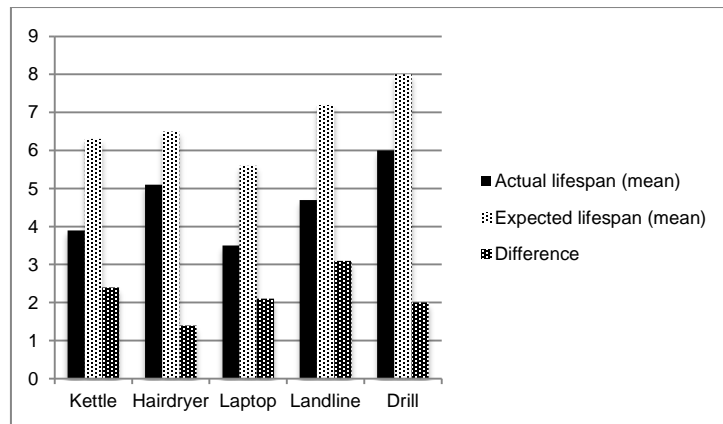


Figure 1: Actual and expected lifetimes of the most commonly reported broken product in each sub-category

In terms of value for money, it might be expected that Premium products have longer lifetimes than budget and mid-range categories, although it is known from DEFRA (2011) that whilst price is often seen as a proxy for quality, and lifetime, it is seen as unreliable by consumers. This observation was borne out in the findings of this study, with broken premium products being reported at a higher frequency than broken mid-range products, and mid-range products on average lasting longer than premium products (see Table 3).

Type of product	Average no. broken products reported per respondent	Average lifetime	Average expected life time	Difference between expectation and actual lifetime
Budget	4.5	3.2 years	4.2 years	1.0 year
Mid	3.7	4.2 years	6.8 years	2.6 years
Premium	4.2	3.8 years	5.9 years	2.1 years

Table 3: Breakage rates, average lifetime and expected lifetime by type of product

Whilst budget range products performed less well on frequency of broken products and average lifetime, they met expectations of consumers regarding lifetime better than either of the other two categories, with mid-range products performing least well in this area.

3.3. Self-Mending Behaviours: A Typology

The results from the extensive survey allowed for segmentation of the consumer base by repair typology taking into account socio-economic demographics and the motivations to mend and barriers to mending articulated by respondents. A typology of three mending behaviours was established using an exploratory data analysis approach and indicative

(rather than absolute) socio-demographic and lifestyle traits associated with these categories.

The three typologies were:

- 'Fixers' - those that always attempted repairs (14% of responses)
- 'Sometimers'-those that attempted repairs on some but not all products (38% of responses)
- 'Non-fixers'-those that had not attempted repairs in the past (45% of responses)

Within the typology of Non-fixers, a further small sub-group was identified – that of 'Extreme non-fixer'. These Extreme non-fixers comprised about 1 in 7 of the Non-fixer cohort, and indicated in their responses that they have not mended any broken products, and nor do they have any desire or intention to mend anything in the future. This sub-group is almost exclusively female (90%), tend to be slightly older than the Non-fixer group and tend to earn slightly less than the non-fixer group.

Furthermore, participant responses to five socio-demographic indicators (gender, age, income, employment and education) and sixteen lifestyle questions, grouped into respondent's views about the external world, respondent's views about themselves and respondent's behaviours, were analysed to further define the mending typologies.

Attitudes relating to Environmental Issues

The findings indicated that Fixers are likely to strongly agree that environmental issues are important to them than other groups. They are more likely to strongly disagree that how something looks is more important than how it works. Non-fixers are least likely to strongly agree that environmental issues are important, and more likely to agree or strongly agree that material wealth is important to quality of life. Sometimers sit in the mid-point of most of the external world scales, although are more likely to strongly agree and agree that it is important to reduce waste in the UK than other groups. Fixers are more likely to strongly agree that they are practical and creative people, and much more likely to agree they have an alternative lifestyle. They are more likely to strongly disagree to being technophobes, and are less likely to see style and fashion as important.

Attitudes relating to Style and Fashion

Non-fixers are more likely to see themselves as less creative and practical than other groups, and more non-fixers strongly disagree that their lifestyle is alternative. Style and fashion are more likely to be seen more important to Non-Fixers than the other cohorts. Non-fixers are the least likely to see themselves as technophobes (when 'disagree and strongly disagree')

are combined). Sometimers once again tend to sit in the mid-point of the scales between non-fixers and fixers when asked views on themselves.

Attitudes relating to DIY

Fixers are much more likely to strongly agree or agree that they enjoy DIY, and that they like to understand how mechanical and electrical things work. They are much more likely to strongly agree that they recycle regularly, enjoy the outdoors and seek out bargains, although when combined with those that agree, these factors are not dissimilar to other groups. Non fixers are more likely to agree or strongly agree that they enjoy shopping for new household items, are least likely to enjoy DIY and least likely to want to understand how electrical or mechanical items work. Again, Sometimers appear to sit in between the other two groups on the behavioural indicators used, although they appear slightly more likely to recycle regularly. Attitudes to risk appear to be shared across the three typologies.

Purchasing Behaviour

In terms of purchasing behaviour, Fixers are slightly more likely than other groups to purchase Premium products; the Sometimers are more likely to purchase Budget products and Non Fixers slightly more likely to purchase Mid-range products.

3.4. Barriers, enablers and motivations for self-repair

Non-fixers and Sometimers were asked to indicate why they chose to discard, rather than mend an item. For Non-fixers, the main reason cited was that the cost of a new product was so low, they may as well buy a new product (45%), followed by not understanding what was wrong with the product (44%), and not understanding how electrical equipment works (34%). Safety also played a part in Non-fixers decision making, with 31% reporting that they were concerned that repair attempts may make the product unsafe.

For Sometimers, whilst cost was a consideration cited by many (48%), their main barrier was they did not understand what was wrong with the product (52%). They also cited inability to access the product as it was sealed as a reason for not mending (45%). Time available to make repairs was also cited as a more significant barrier to Non-fixers (30%) than Sometimers (17%).

Both Non-fixers and Sometimers cited the same top four factors to encourage repair attempts, although gave different weight to all but the top factor - easily accessible written information (62% and 70% respectively). Sometimers cited if they could easily buy new

parts as the second reason (60%), followed by no specialist equipment needed (57%) and a product that self-diagnosed (43%).

Overall, Non-fixers responses were lower on each of the possible encouragement factors offered in the survey, with around 1 in 7 responding that they 'could not imagine attempting to repair anything in any circumstances' – the sub-group of 'extreme non-fixers'. For those that did respond positively, the second highest encouragement factor was for a product that self-diagnosed (49%), if no specialist equipment was needed (41%) and if new parts could be easily purchased (39%).

Sometimers and Fixers were asked what motivates them to attempt repairs on products. Again, the top four responses in each group were the same, but different emphasis was placed on different factors. For Fixers, they reported that they attempt to mend because they are rewarded with a sense of personal satisfaction (73%) and enjoy the technical challenge (68%), with half of all fixers then citing a waste of natural resources and money not to fix. Sometimers focused on the monetary motivation primarily (60%), with personal satisfaction (58%) and enjoyment of the technical challenge (48%) being cited as the second and third motivations, and waste of natural resources (33%) as the fourth most common factor.

Over 40% of Fixers cited the reason 'I like to outwit companies that make products with a limited lifespan', with significantly fewer Sometimers citing this reason (7%). The inability to afford to replace the product was not seen as a common motivation for either group.

3.5. Challenges when undertaking repairs and success rates

Sometimers and Fixers were also asked what their top challenges are when undertaking repairs. To an extent, these challenges mirrored the enablers discussed earlier, with Fixers citing insufficient information from manufacturers (41%), inability to test which components were faulty (36%), need for specialist equipment to access the product (36%) and inability to purchase new parts (36%) as their top reasons. Sometimers top challenge was cited as not understanding what the fault was (37%), and whilst they too cited insufficient information from manufacturers (32%) and the need for specialist equipment to access the product (32%) as challenges, they also noted that there was little advice available on how to undertake the repair (30%).

Fixers and Sometimers reported their success rates for repair attempts, with Fixers reporting on average a 45% success rate in terms of fully mending a product, and a further 45%

success rate for repairing products in part, or repairing some but not all products. Sometimers were not as successful, reporting a 32% success rate for full mend, and 37% success rate for partial mending.

A summary of the key attributes of the three mending typologies can be seen in Table 4.

	Fixer	Sometime	Non Fixer	Extreme Non-Fixer
Gender / home life	Male	Male or Female	Female	Female, older, no children at home
Earnings	<£50k	£50k	>£50k	£50k
Employment	Part time	Employed	Full time	Self employed
Qualifications	Tertiary or Vocational	Various	Secondary Education	
Purchasing Habits	Premium Range	Budget and Mid-range	Mid-Range	
Likes and Dislikes	Practical, enjoys DIY, leads alternative lifestyle, likes to understand how things work, not style or fashion conscious	Care about waste reduction, recycle regularly	Style/Fashion conscious and sees material wealth as important. Enjoys shopping. Not practical or creative, does not enjoy DIY, not interested in how things work	
Motivations to mend	Personal Satisfaction	Waste of money not to	None	
Barriers to mending	Information from manufacturer lacking, no easy way to test for faulty parts, specialist equipment needed, new part purchase difficult	Unclear what the problems are with products, information from manufacturer lacking, specialist equipment needed, little advice available	Products so cheap, I can buy new, unclear what problems are with products, do not understand how electrical equipment works	Not interested in fixing anything, ever

Table 4: Summary of Self-Mending Typologies Attributes

The comparison of factors enabling and impeding repair identified in the literature and those discovered as a result of the extensive survey indicates that there are, in fact, marked differences regarding the extent to which different factors influence the decision to mend or dispose of products between typologies. As such, these findings create a richer picture than has been perhaps suggested in previous studies, where cost of repair (ERM, 2011) and safety concerns (Chismar, 2008) were identified as universal barriers to repair.

To encourage repair, the specific motivating factors for each typology and the barriers they have identified to mending must be responded to within the design of products which enable, rather than restrict, repair.

4. Designing for Repair

This paper theorizes that Design for Sustainable Behaviour (DfSB) could offer a potential opportunity for encouraging product repair and thus extending product life. Design for sustainable behaviour is an emerging activity under the banner of sustainable design which aims to reduce the environmental and social impacts of products by moderating users' interaction with them. DfSB strategies can be categorised on an 'axis of influence' (Lilley, 2009) which correlates increased product control with a corresponding reduction in user interaction and choice, Figure 2.



Figure 2: Axis of Influence

The Axis, illustrated in Figure 2, clearly depicts a choice-control dichotomy. Towards the 'user agentive' end of the scale is feedback, a means by which to indicate the environmental, economic, or social impacts of consumption to the user. Just off the centre of this axis is behaviour steering, an approach concerning the way in which a designer uses the physical characteristics of a product to prescribe a desired behaviour. By consciously 'scripting' a product through the use of affordances and constraints, a designer can control the user's interaction without forcing action. At the opposite end of the scale from feedback are intelligent products and technologies, which persuade the user to adopt new behaviours and ensure their continuation through overt (and sometimes covert) methods, commonly referred to as Persuasive Technologies (Fogg, 2003).

4.1. Outcomes of Design Workshops

Over 30 concepts were generated through the design workshop, with many sharing similar features. Concepts were then consolidated into two or three distinct ideas for each typology by grouping ideas that shared similar features. Eight concepts in total were selected for further development, these are summarised in *Table 5*.

Fixers Concept 1 Construct-a-kettle

Description

The kettle is sold as component parts in a kit along with build instructions – not unlike an adult version of a model plane.



Persona Inspiration

Fixers like to understand how electrical / mechanical products work, and often cite lack of information from the manufacturer as a barrier to mending

Fit with DfSB Spectrum

This concept is at the very end of the Information part of the DfSB spectrum; it inherently requires complete information to enable the build.

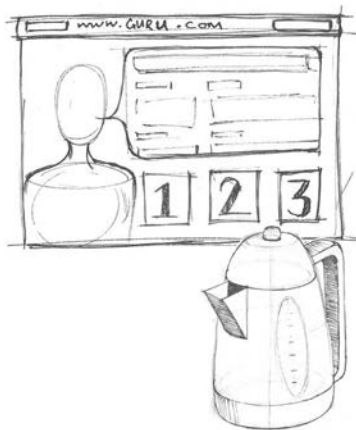
Impact on mending behavior

Fixers will learn from assembling the kettle – this learning and the information provided to undertake the build will decrease barriers to mending

Fixers Concept 2 Guru kettle

Description

This kettle is sold with membership of an on-line community with interactive 'fix-it' guides and forum and new parts purchase facility. Perhaps sold in 3 levels of complexity depending on mending ability



Persona Inspiration

Fixers cite lack of information and difficulty to purchase new parts as barriers to mending. Differing levels of complexity will create new 'challenges' for fixers

Fit with DfSB Spectrum

Information is provided through the on-line community by the provider and augmented with other consumers of the Guru kettle

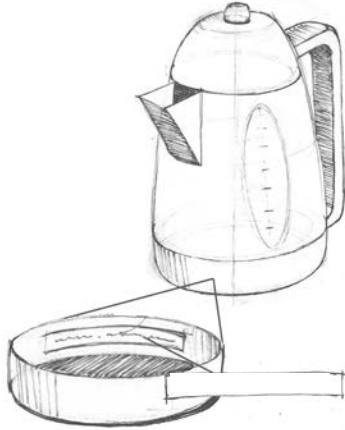
Impact on mending behavior

Fixers are able to easily access information and new parts to enable mending.

Sometimers Concept 1 Hidden Message Kettle

Description

Prompting messages are placed under and inside the kettle, and more are revealed as the kettle is dismantled for mending. Initial message underneath may be placed to encourage women to attempt to mend.



Persona Inspiration

While the gender split in the sometimers category is fairly equal, this may move more women into the Fixers category, which is heavily male dominated.

Fit with DfSB Spectrum

The messages fit into the 'behaviour steering' part of the DfSB spectrum, embedding an affordance.

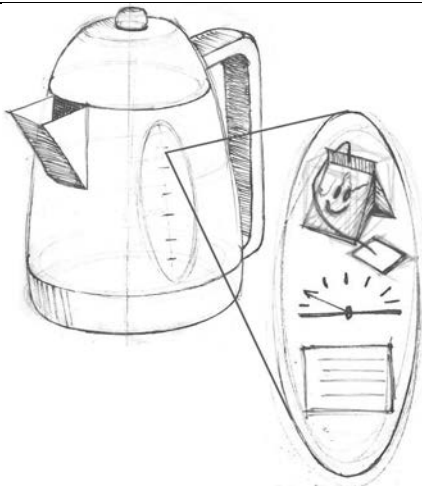
Impact on mending behavior

Friendly messages will encourage sometimers to mend – messages could also in themselves contain helpful hints and mending tips.

Sometimers Concept 2 Tamagotchi Kettle

Description

The Kettle comes with a built in indicator showing its 'health'. The indicator would encourage consumers to take preventative measures to maintain health (such as descaling), show fault diagnosis and offer instructions to mend.



Persona Inspiration

The main barrier to mending is that sometimers do not understand the fault with the product.

Fit with DfSB Spectrum

Steers behaviour by embedding affordances that remove barriers to mending and encourages preventative behaviours

Impact on mending behavior

Automatic fault diagnosis will remove the main barrier to mending in this group. May reduce the need to mend through encouraging maintenance.

Sometimers Concept 3 Kettle and a Fix Kit

Description

The kettle is sold with a kit that contains instructions, tools and spare parts that are commonly replaced. Each part of the kettle is colour coded and the instructions link the symptoms to the diagnosis and the part that needs replacing – e.g. if the power light does not come on, a common cause is the fuse, replace the Blue part.



Persona Inspiration

The three changes that would encourage more mending in this group are easily accessible information, new parts that are easy to buy and no need for specialist equipment.

Fit with DfSB Spectrum

Whilst the supply of the fix kit is not an embedded affordance, it can be seen as a peripheral affordance that will encourage the consumer to behave in the way prescribed by the design

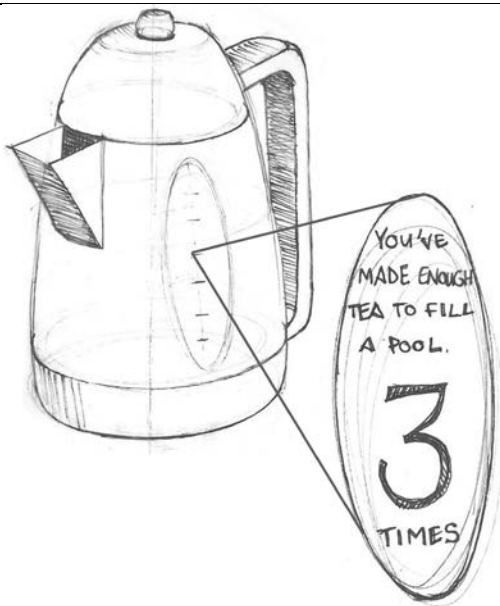
Impact on mending behavior

This concept satisfies the three changes suggested by the survey respondents in this group. Supply of tools may encourage more widespread mending.

Non-Fixers Concept 1 Fact-of-the-day Kettle

Description

Once a week, when boiled, this kettle tells the consumer how many times it has been boiled, and the equivalent volume of water e.g. 'You have boiled me 854 times, which is enough tea to fill a swimming pool'. Facts change each week



Persona Inspiration

Replacement cost was the most common reason this group do not mend – inspired to motivate the group on an emotional rather than monetary level

Fit with DfSB Spectrum

Whilst the concept does not absolutely ensure behaviour change, it may well persuade people to behave differently as they (perhaps unconsciously) build a more emotional attachment to the product

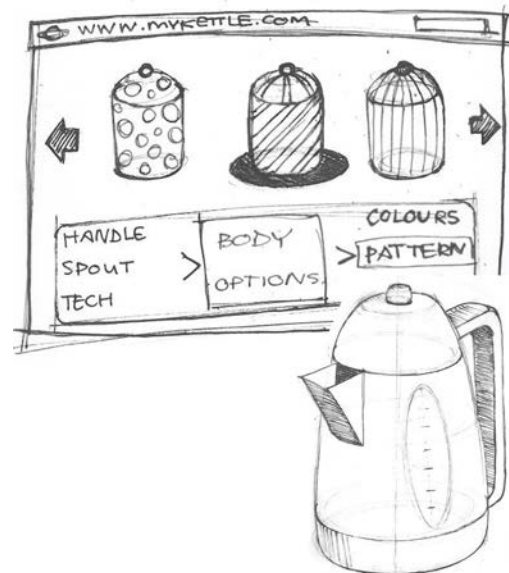
Impact on mending behavior

May persuade consumers who do not mend to consider mending as their 'account' with the kettle (the number of times it has boiled) increases. Disposing of the kettle may feel like 'starting again'.

Non-Fixers Concept 2 my.kettle

Description

On-line kettle design and build for fully customised kettles. Each part is available in various patterns/colours/photo prints, and can be ordered as a stand-alone part or built into a complete kettle. Accessibility to each part is on the outside of the unit and each part can be easily swapped. Parts can come in 'ranges' for, for example, seasonal or family events (births, marriages, Christmas). On-line diagnosis of fault (similar to NHS direct), which then links to replacement part order and design selection.



Persona Inspiration

Many non-fixers are style/fashion conscious and do not understand what is wrong with the product.

Fit with DfSB Spectrum

Whilst the concept does not absolutely ensure behaviour change, it may well persuade people to behave differently as they (perhaps unconsciously) build a more emotional attachment to the product

Impact on mending behavior

Reduces potential impact of aesthetic obsolescence by allowing consumers to customise (and change) designs as new parts are required. On-line fault diagnosis linked to replacement parts encourages mending.

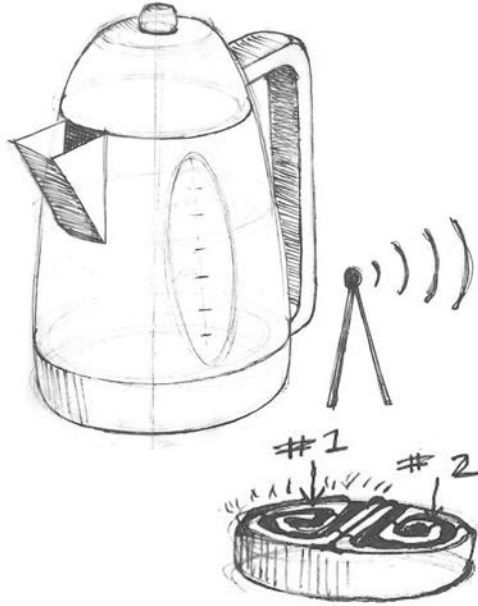
Non-Fixers Concept 3 Ever-lasting kettle for Extreme Non-Fixers	
<p>Description The kettle is sold as part of a product-system-service. The kettle contains back-up but redundant working parts, that only begin to work as the primary functioning parts break. The kettle sends a signal to the manufacturer that primary parts have failed. Manufacturer contacts consumer to arrange repair of primary parts – even though the kettle is still functioning.</p>	
	<p>Persona Inspiration Extreme non-fixers are not interested in mending, view replacement costs as low and do not have the time to undertake mending.</p>
	<p>Fit with DfSB Spectrum Whilst this concept does not encourage self-repair, it does ensure change at the persuasive technology end of the spectrum – the consumer is unaware that the product has a fault until the repair is arranged.</p>
	<p>Impact on mending behavior Increases likelihood of repair (albeit not self-repair) through a PSS model, perhaps covering all kitchen equipment. Negates current barriers to repair in the extreme non-fixers group.</p>

Table 5: Summarised design concepts emerging from ideation workshop

4.2. User Evaluation

Table 6 shows the eight concepts together with the corresponding point of the DfSB spectrum across the top of the table, with the 12 interviewee responses down the side of the table. The top three choices and last choice are shown for each interviewee. From Table 6 it can be seen that different typologies preferred different concepts to differing extents. At the extreme ends of the Design for Sustainable Behaviour spectrum, there is a more definite correlation between concepts designed for typologies and the typology preferences exhibited. On the whole Fixers preferred the concepts focused at the information end of the DfSB spectrum and Extreme Non-fixers and Non-fixers preferred concepts generated at the persuasive technology end of the spectrum. The concepts they ranked last are generally on the opposite end of the DfSB spectrum from their target designs.

	Fixer 1 Concept Construct-a-kettle 	Fixer 2 Concept Guru Kettle 	Sometime 1 Concept Hidden Message kettle 	Sometime 2 Concept Tamagotchi Kettle 	Sometime 3 Concept Kettle and a fix kit 	Non-Fixer 1 Concept Fact of the day kettle 	Non-Fixer 2 Concept My.kettle 	Extreme Non-fixer Concept Everlasting Kettle 
DfSB Spectrum	Feedback ←		Behaviour Steering			Intelligence (Persuasive Technology) →		
Fixer 1 Interviewee	✓✓	✓✓✓				✓		X
Fixer 2 Interviewee	✓✓✓	✓✓			✓			X
Fixer 3 Interviewee	✓✓✓		X		✓✓	✓		
Sometime 1 Interviewee	✓✓✓		X	✓	✓✓			
Sometime 2 Interviewee	✓			X		✓✓✓	✓✓	
Sometime 3 Interviewee	X		✓	✓✓				✓✓✓
Non-fixer 1 Interviewee		X			✓	✓✓	✓✓✓	
Non-fixer 2 Interviewee	X			✓			✓✓	✓✓✓
Non-fixer 3 Interviewee	✓✓				✓✓✓	✓		X
Extreme non-fixer 1 Interviewee					X	✓✓	✓	✓✓✓
Extreme non-fixer 2 Interviewee	X					✓	✓✓	✓✓✓
Extreme non-fixer 3 Interviewee		X		✓✓			✓✓✓	✓
KEY	✓✓✓		✓✓	✓	X			
	First Choice		Second Choice	Third Choice	Last Choice			

Table 6: Summarised evaluation results

During the interviews, Fixers 1 and 2 commented that the Everlasting Kettle, designed for Extreme Non-fixers, represented a “complete waste of resources” given its inclusion of redundant working parts, whilst Extreme Non-fixer 2 commented that “they would be useless” at attempting the Construct-a-kettle concept, designed for Fixers.

Sometimers showed a different pattern – their preferences fell across the spectrum from those designed for Fixers, to those designed for Extreme non-fixers, perhaps reflecting their less definitive self-mending behaviour – sometimes they choose to mend, at other times they do not.

The most common concept to appear in the top three choices across the typologies, the Fact of the Day kettle, was rated highly across groups as it “would spur me on to keep it, to get a higher and higher number” (Fixer 3) and “would encourage me to maybe have a go at mending it so I could monitor just how many cups of tea I actually make” (Extreme Non-fixer 1).

All twelve interviewees stated that their ranking of the top three choices was based on the design intervention intended. All but one individual stated they would be interested in purchasing at least one of their top three choices. Whilst all groups were willing to pay a higher premium for their purchase choice, Extreme Non-fixers would be willing to pay the highest average premium at 24% higher than a standard kettle, perhaps reflecting the inclusion of additional features or services in their concept selections. Fixers were willing to pay the lowest premium (3% higher), and would not be prepared to pay extra for the Construct-a-kettle concept, given that “I am making it myself” (Fixer 2). Sometimers were willing to pay an average 13% premium for their selected preferences.

5. Discussion

It is recognised that designers have a vital role to play in changing consumer mindsets and putting design for repair on the agenda (Elam, 2012). To better facilitate customer-led repair a change in practice is needed, yet this shift also requires designers to embrace new models of designing, shifting from solutions-led thinking (which perpetuate the status-quo and feed the consumerist mentality) to transformational models which facilitate longer-lasting, deeper attachments to products and cultivate stewardship, care and regard rather than transient relationships (ibid). This research explored the use of a Design for Sustainable Behaviour framework in the context of self-repair, developing behaviour-changing products by matching

the typologies and personas developed with different points on the DfSB spectrum. Applying this strategy offered inspiration to the group of designers, resulting in the successful development of eight specific concepts focused across the DfSB spectrum in a relatively short concept generation workshop. During the workshop, participants recognised the 'fit' between the personas developed and the level at which the DfSB intervention was aimed. Whilst inspiration was drawn from the persona information, participants found it most challenging to develop concepts that forced non-fixers towards self-mending i.e. concepts at the persuasive technology end of the DfSB spectrum. The concepts developed for this group relied either on changing the emotional attachment an individual feels towards a product, to influence the monetary mental calculations performed when considering the mend or dispose question, or employing a product-service-system, where the product is mended by a third party. The evaluation of the concepts generated suggests that using DfSB as a design tool results in interventions that are likely to appeal to the different typologies identified, and therefore encourage self-mending behaviour for a range of different consumers. Although the focus of the ideation workshop was to develop concepts for kettles, many of the concepts discussed above and the methodology used are generally transferable to other household electrical items. Such a strategy could, therefore, be applied more widely to other products and services that present significant environmental challenges. One exception to this may be products that are subject to technological obsolescence such as mobile phones and computers. Further research in this area would be beneficial to test the application of the DfSB spectrum to this product category.

Whilst this paper has focussed ostensibly on the role of design, it is recognised that product level innovation is not sufficient on its own to motivate an uptake in repair behaviour. The socio-political landscape must also be adapted to better support new business models and product design paradigms which encourage repair. This is likely to be a challenging endeavour, requiring many obstacles to be overcome. In an industry which relies on planned obsolescence to stimulate repetitive consumption and generate continued profits (Guiltinan, 2009), extending product life spans through repair may be considered counterintuitive by manufacturers wishing to maximise short-term profit as "the more reliable and long-lasting the product, the longer the repeat purchase cycle and the slower the rate of sales growth" (Guiltinan, 2009: 21). Furthermore, it could be argued that acceleration of technological advancement through the constant renewal of products to leverage competitive edge (Fishman et al., 1993) may be arrested if planned obsolescence were replaced by design for repair. It is also possible that R&D costs will increase leading to a corresponding increase in retail prices and that, as a result, consumers will not purchase products designed for repair. Yet, as "labour is the largest component of a repair" (McCollough, 2009) effectively

outsourcing repair to willing consumers would reduce manufacturers overheads potentially offsetting design costs incurred through augmenting the product specification to enable partial access for customer-led repair and maintenance. Furthermore, it can be argued that the financial burden caused by product recovery and recycling under the WEEE directive is already passed on to the consumer at the point-of-purchase.

Yet, if we are to truly tackle rapidly advancing consumption and rising waste, we cannot continue to perpetuate the linear “take-make-waste” model. We must challenge and debunk the prevailing notion that growth and profit may only be achieved through perpetual sales of new appliances we must also counter the ‘conditioning’ of minds which have turned citizens into consumers. To facilitate a transition away from the throwaway society towards a cyclical economy, a radical rethink is needed. Changes to the legal system are needed to address the “paternalistic” nature of product safety legislation and an increasingly litigious society which have, arguably, disempowered consumers (Chismar, 2008). The overarching intention of self-repairable product design is not to grant unlimited access to the inner workings of complex electrical goods, a pursuit which would, quite rightly, be considered irresponsible and fool-hardy and, in all probability largely unpalatable to both manufacturers and consumers alike, but to operate within the boundaries of acceptable personal risk and provide opportunities for engagement. Indeed, proponents of repair advocate that legislative changes are needed to “allow consumers the option to take on, by consent, the liability and increased personal responsibility for risks incurred as a result of attempting their own repairs” (Chismar, 2008: 25) or that manufacturer approved ‘self-servicing’ programmes must be enacted to enable customers to repair their products within existing legal boundaries. In practical terms, access could, for example, be restricted to designated areas needed to carry out basic repairs and maintenance or troubleshooting functions.

Customers must be educated and product pricing made more transparent to ensure that purchasing decisions take account of the longer term costs associated with items at the lower end of the price range which, arguably, compromise quality and durability for price competitiveness. Repair must be incentivised through financial means. Lowering the VAT on repairable products or offering extended warranties have both been mooted as a possible means of enabling more widespread repair (ERM, 2011). However, these proposals must be carefully considered to ensure the likelihood of increased purchase prices resulting from the transference of costs borne by manufacturers for implementation, do not discourage their take-up.

Finally, it should be acknowledged that even where repair is considered desirable and achievable there is often a point at which the consumer no longer considers the product worth repairing if its emotional or fiscal value has depreciated over time, if the running costs are prohibitive or if faults persistently occur (Cooper, 2010). Additionally, replacing an old appliance to maximise on efficiency gains derived from newer technologies may be more beneficial than keeping it for longer (Bhamra and Lofthouse, 2007). It is essential, therefore, that the product lifetime is “optimized” (Van Nes and Cramer, 2005), that the point at which repair is no longer environmentally beneficial is recognised and that factors which contribute to psychological obsolescence are identified and dealt with.

6. Conclusions

The aim of the research reported on in this paper was to establish the extent to which Design for Sustainable Behaviour (DfSB) strategies can be applied to a product in the category of small electrical household goods to encourage self-repair to extend product life. In meeting this aim and the associated objectives of understanding both the target products, the consumers, and combining this understanding to develop and evaluate product concepts, this research offers insights that span a number of fields.

This research explored in detail different attitudes towards self-mending, an area that has been largely ignored in previous studies. A rich picture of different mending typologies and associated demographic and lifestyle indicators has been established, as well as an assessment of the extent to which barriers and enablers to repair impact on the decision to self-mend for different typologies. Segmentation of consumers by typology, and associated development of different personas has not been undertaken previously in this field. The research has also demonstrated the potential value of applying Design for Sustainable Behaviour (DfSB) strategies to the challenge of designing for repair, moving beyond purely pragmatic design considerations to encompass issues of behavioural determinants, aspirations and lifestyle considerations. This approach has enabled products to be conceptualised that target different personas with the aim of designing interventions that appeal to different but specific motivations, lifestyles and demographics associated with each typology to encourage self-mending. In addition to specific product concepts for different typologies, it has also been recognised that standards can be enacted, regardless of the target typology, to ensure appliances are designed for repair. In practical terms this encompasses the use of transparent product architecture and standardised hardware that does not require proprietary tools; location of replaceable parts or problem-components which are probable candidates for failure in easily accessible positions; incorporating self-diagnostic systems designed with user input, a comprehensive labelling system which

denotes the purpose and functionality of components and comprehensible repair manuals for non-specialists. In conclusion, this study has demonstrated that Design for Sustainable Behaviour can indeed offer designers and manufacturers potential interventions that counteract the 'throw-away society', and instead create a pathway to extending product lifetimes by enabling and encouraging a behavioural shift away from replacement and towards repair.

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