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Cosmetic obsolescence? User perceptions of new and artificially aged materials

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ABSTRACT

This paper presents the findings of a user study which explored tactile and aesthetic responses to new and artificially aged mobile phone cases made from bamboo, walnut, cork, leather, brushed titanium, plastic and rubber. The paper outlines test methods for accelerated ageing of the external enclosures of consumer electronics based on the types of wear experienced in use, and the use of semantic differential scales (SDS) to probe user attitudes to these materials. The results indicate that preferences for the materials tested were extremely subjective, and even a single participant can have conflicting requirements for the characteristics of the materials (for example, sleek and shiny yet easy to grip). Whilst in general participants preferred the new materials and saw the ageing process as negative, there were examples where the aged samples either scored more highly due to durability (titanium) or received positive comments about the aesthetic changes caused by severe ageing (bamboo and leather). This study captured the participants' immediate, visceral response to the materials, which may be very different to their feelings towards materials and objects that they have owned and interacted with for a period of time.

1. Introduction

The rapid turnover of consumer electronics, fuelled by increased consumption, has resulted in negative global environmental, social, and economic consequences [57]. Electronic waste (e-waste) is typically disposed of into UK landfills or to developing countries, incinerated, stored in a redundant state (also known as 'hibernating') or otherwise 'lost' - very few are effectively recycled. Materials scarcity of non-renewable, finite resources is a global concern and one that UK consumers and manufacturers cannot ignore. To use these resources more efficiently and reduce e-waste, consumers must be encouraged to retain their devices for longer and return them at the end of their life (or before). To assist in a transition from the current throw-away society towards a circular economy, the UK Engineering and Physical Sciences Research Council funded the CLEVER project (2013–2016) which is developing materials which aim to engender emotional attachment to the external enclosure of fast moving consumer electronic devices, to motivate continued usage and facilitate the return of the internal electronics for upgrade rather than disposal. The aim is to enable the efficient recovery of the valuable, high impact metals in the internal electronics and allow them to be re-used in a closed loop.

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2. Literature review

Although it is hard to quantify with any precision, it is widely considered that the 20th century saw a downward trend in the lifetime of products [16,43,48]. This trend has continued since 2001 with a 10 to 20% reduction in the time that EU consumers keep household appliances before disposal [22,31]. The Organisation for Economic Co-operation and Development (OECD) identified that the long-term increase in income and access to credit has also seen a rise in the total number of objects that households own [39]. According to the Office for National Statistics (ONS), only with the financial crisis of 2008 has household consumption reduced, but even this period of slowing returned to growth at the end of 2011 [37]. This level of consumption has led to an associated rise in household waste, which currently stands at over 22 million tonnes a year [38] in England alone, with almost one million tonnes of this coming from electrical and electronic equipment [23]. The impact of increasing household waste has been partially mitigated by improved recycling rates, which have climbed from 10% to 40% in the last decade [17], but recycling (or often 'downcycling') only offers a 'least bad' solution to waste [6,16]. Recycling infrastructure including transportation and processing consumes significant amounts of energy, as does reusing the recovered materials [15], so it cannot effectively close the consumption loop. Furthermore, recycling rates are levelling off [17] so as consumption continues to climb, the levels of waste will increase. Recycling cannot mitigate the impacts of the consumer society by itself, and five times as much waste is created during

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the manufacturing process than remains when a product is disposed of at the end of its life [32].

"*The circular economy represents a development strategy that maximises resource efficiency and minimises waste production, within the context of sustainable economic and social development*" ([60], p. 2). Greater circularity could mitigate lifecycle impacts (Hislop & Hill, 2011), but circular economy may not be enough on its own to realise a sustainable system if the consumption of resources continues to increase as this would offset any improvements in efficiency [16]. So, it is also necessary to reduce the rate at which resources are consumed by slowing replacement cycles [16,61]. Lifetime optimization is recognized as a key resource efficiency strategy [10,62]. Designers are well-versed in designing for longer-life through increased material robustness, physical durability and design for repair and maintenance. Achieving a long-lasting emotional connection, however, is far more challenging particularly in today's consumerist society in which credit is plentiful and a culture of instant gratification prevails.

The reasons for obsolescence can be broadly grouped as technical (new products incorporate technological advances), functional (the product no longer works) and aesthetic (the new product looks more desirable) [16,43]. Consumer electronics "*tend to occupy a synthetic and scratch-free world of slick polymers…*" ([11], p. 141) with wear and damage to the pristine external enclosure widely considered to contribute to premature replacement of 'tired', 'worn' or 'damaged' devices [20, 35,36]. The prominent aesthetic change caused by minor wear and damage to pristine enclosures, combined with incremental upgrades in hardware and regular tweaks to styling all contribute to the rapid turnover of these devices. This research focuses on addressing "*cosmetic obsolescence*", the physical changes that occur on a product or material over the use period that alters the perceived look and feel of a product or material resulting in a shortened product lifespan [29].

Natural materials including wood, leather, stone and some metals are commonly described as 'ageing gracefully' and develop a 'patina' which is valued more highly than the new material [9,36,45,49]. Depending on the material, this 'patina' is caused by gentle wear and polishing, and reaction to ultraviolet light and/or chemicals (typically water and oxygen). Examples include 'verdigris' - the durable, green surface finish of weathered copper which is highly valued as a building cladding material, and complex changes in wood due to weathering which tend to emphasise both the visual appearance and texture of the grain [19]. The manufacturing process and surface finish are also crucial in determining the final appearance and ageing behaviour of the material [45]. In stark contrast, man-made materials such as plastic, glass and stainless steel are manufactured in a pristine, shiny, uniform state and as such do not provide the potential for timeless beauty [54]. It has been suggested that the 'temporary shininess' of consumer goods as a material quality reflects the transient and superficial nature of postmodern culture [28]. In contrast to the formation of 'patina' described above, the effects of wear, ultraviolet light and chemicals have deleterious effects on these materials. Plastic objects can start life delighting us with their pleasurable sensorial properties (smoothness and glossiness), however, after a short time our pleasure turns to disgust due to the deterioration of these properties [20]. The discolouration of plastics due to UV exposure is particularly unappealing, both aesthetically and functionally as the material may become brittle. The associated loss in perceived value can lead to dissatisfaction [8,50] reducing the lifespan of certain products through premature disposal in favour of a 'shiny new one'.

Previous studies have revealed meanings embedded within specific materials, such as metal implying precision and technological superiority [25]; metallic materials with smooth surfaces eliciting positive emotional responses and rough metallic surfaces eliciting negative emotional responses [58]; as well as plastic being considered the most displeasurable and least pleasurable family of materials [4]. However, most studies utilize new rather than aged materials and as such fail to account for material changes attributable to wear and the resulting effect on user perceptions. Yet, as discussed previously, 'newness' or 'shininess' within consumer electronics is a fleeting material quality and dissatisfaction can ensue as a result of temporal material changes. Chapman [11]) proposes that materials which physically age well and develop a tangible character through time and use may potentially engender greater emotional value, offering a viable pathway to longevity. The creation of a patina writes a narrative into the materials of the product, and through this a shared history is expressed; "*whether deliberate or unintentional, every crack and scratch that materials manifest as we interact with objects inscribes a story*" ([21], p. 473; [46]). Patina is not "*to do with material resilience or durability, but rather, a societal preoccupation with what an appropriate condition is for certain typologies of materials and objects to be in*" ([11], p. 141). Unfortunately the distinction between 'patina' and 'degradation' is not well defined, and is highly subjective. In addition, little is known about attitudinal responses to 'aged materials' nor the potential for value to be ascribed to incidents of material change. Given the resurgence of interest in the 'materiality of interaction' with digital devices [53] this paper makes a timely contribution to address these questions.

3. Methods

The following section reflects on the methods employed for material preparation, data collection and analysis of the user study, aiming to uncover and explore users' tactile and aesthetic responses to new and aged portable consumer electronics.

Consumers interact with materials through products [2]. The function of an object directly affects the way we perceive the materials from which it is made and what these materials express [24,25]. Yet few material studies exploring tactile and aesthetic preferences focus on individual products - most utilize small swatches of material devoid of context (e.g. [42,58]). To counter this limitation of previous studies, and to link perceptions to a relevant product, mobile phone cases made from a range of materials have been used as a rapid, cost effective method of allowing people to interact with the same object enclosed in different materials.

3.1. Preparation of artificially aged mobile phones

Mobile phone cases made from lacquered bamboo, walnut, cork, leather, brushed titanium, plastic and rubber were used (Fig. 1). The materials were chosen to include typical man-made materials currently used for mobile phone exteriors (titanium, plastic and rubber), and a range of different natural materials (bamboo, walnut, cork and leather) to explore the different response to wear and ageing of 'shiny' man-made materials and textured, variable natural materials. One set remained in pristine, new condition, and the other was artificially aged.

Product testing of electronic devices by manufacturers typically focuses on avoidance of functional failure, not gradual wear and longevity, and there were no published methods or standards for accelerated wear testing for this type of product. Therefore, we developed test methods for accelerated ageing of consumer electronics based on the types of wear experienced in use and manufacturers' videos of their durability testing (link to video: https://www.youtube.com/watch?v=HicdXV_47V8). We divided the wide spectrum of possible degradation mechanisms into two processes:

1. Wear - analogous to careful use and handling, and carrying in a pocket or case, which will gradually polish the material over time. To accelerate this form of wear a handheld polisher was used with different grades of polishing disc for different materials. Whilst it would be desirable to standardise the test method for all materials, the effect of different grades and durations of polishing on different materials varies too widely, such that the test method must be tailored to each sample and a degree of 'craftsmanship' employed in applying a suitable amount of polishing to each sample.