A Landscape of Repair

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The relationship between product repair and the circular economy

The research that informed this paper stems from one of a number of small EPSRC funded projects that explore the relationship between circular economy, redistributed manufacture and the nature of the data required to support a shift in the mind-sets and business models of manufacturing. Our project, Business as Unusual: consumers in the loop, focuses on the opportunity for different types of product-people interactions to create new business models that influence how redistributed manufacturing can support systems of circular resource flow. The primary rationale for such a drive is to counter the increasing levels of product consumption and product waste. According to the Energy Saving Trust in Great Britain, the number of electrical appliances and devices in households has increased steadily over the past 40 years; tripling from the 1970s to 2002 (Whilhite 2016). Research also indicates that people are more likely to replace products with high technological innovation at a faster rate even when those products are still functioning (Cooper 2004). Such growth in product consumption illustrates a resource system that is dominated by a linear flow of products and as such, reflects a system that is in trouble. This fast-tracking of products through the make-use-dispose linear cycle ultimately results in large amounts of valuable resources being lost to landfill, and large amounts of energy wasted in production, collection and disposal. Initiatives that intervene in the throwaway culture's linear flow of resource are increasingly in evidence; for example the Swedish government has recently proposed to support a repair economy through introducing tax breaks on all repair activities (Orange 2016).

A circular economy aims to reverse this trend through a more sustainable model of consumption employing different initiatives and strategies to move towards a resource efficient model (Piscicelli, Cooper & Fisher 2015), where quality, durability, recyclability, locality and reparability are valued (Crocker 2015). The Circular economy can be defined as ‘an industrial economy that is restorative or regenerative by intention and design’; it proposes a restorative way of consumption with a closed loop where materials, products and components are kept longer in use and no waste is generated (Ellen Macarthur Foundation 2013). There are five different principles the circular economy is based on: design out waste, build resilience through diversity, shift to renewable energy sources, think of systems and think in cascades (Ellen Macarthur Foundation 2013).

Slowing the trajectory of product consumption is one of many business strategies that support the creation of circular economies (Bocken, Pauw, Bakker & van der Grinten 2016). However it presents many challenges to a conventional wisdom that connects economic growth to a rate of consumption of resource measured in gross unit sales (Jackson 2009, Cooper 2005).

Figure 1 (Cooper 2005), shows the critical relationship between the drivers of efficiency and sufficiency in achieving sustainable consumption. Too much emphasis on efficiency promotes continued consumption, albeit of more resource efficient products. This has been the predominant strategy of policy and business to date in integrating environmental concerns within a production context. On the other hand an over-focus on sufficiency-based initiatives could have the effect of slowing consumption to such a degree that an economic recession results. Strategies that increase

product lifespan offer the potential to realise product life extension alongside delivering product and system infrastructures that consolidate the ambition of resource circularity through promoting quality, durability, recyclability, locality and reparability.

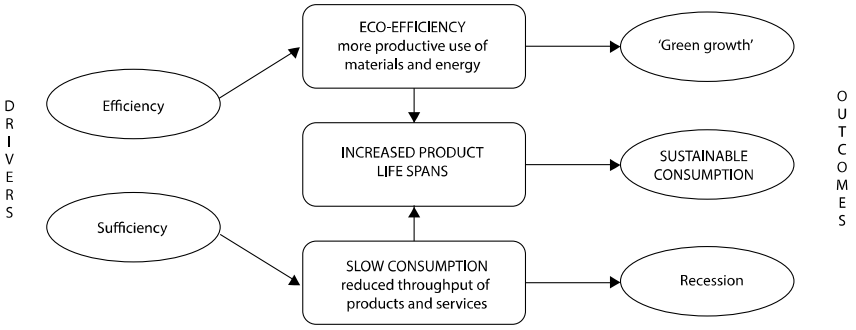

Figure 1 Product life spans and sustainable consumption (Cooper 2005)

This paper reports on an element of the funded project that investigated the product life stage of repair. Repairing products, and the lifetime care of products, are acts that extend product life and as a result, contribute to a slower rate of consumption. Consumption is not only defined by the act of purchasing goods, but also the daily practice and interactions people have with their products (Connolly 2008), particularly those products that consume resources in use (e.g. energy and consumables such a detergent and printer ink). Activities of consumption therefore involve routines developed between user and product, through its use, purchase, maintenance, repair, recycling and eventual disposal (Tang & Bhamra 2009). With this in mind, product life extension strategies may not be the most sustainable solution, in particular where the technology of an older product is superseded by more efficient technologies found in newer models (and therefore newer models have lower impacts during the use phase). Thus, the best case from a circular resource perspective should be considered carefully for different products. For example, it is acknowledged that a washing machine has significant resource impact due to its energy consumption during use. However washing machines contain energy intensive materials and have significant embodied carbon impacts, which are not taken into account (Braithwaite, Densley-Tingley & Moreno 2015). Thus products such as these should instead stay in use for longer delivering the necessary performance across an extended use phase. This will be achieved through better product lifetime care as well as the creation of more durable products (Bakker, Wang, Huisman & Den Hollander 2014).

Exploring 'repair' provided a means to illustrate peoples' interactions with their products long after the usual new product development consumer based interactions had occurred (e.g. market information from focus groups and questionnaires). At the repair stage of a product 's life people have opportunities to make different choices that affect the longevity of a product. This research looked at the motivations of people to undertake acts of repair and the interventions that were used to extend product life.

Exploring product repair

In recent years there has been a growing grassroots movement to support the repair of consumer products, anything from clothing and bicycles to consumer electronics. Many of these initiatives are community-run events relying on volunteers to provide their time, skills and tools to extend the life of different product types. Probably the best known of these are Repair Cafes - an international community founded in the Netherlands with the first Repair Cafe held in Amsterdam in 2009[1]. Similarly

[1] The Repair Café was initiated by Martine Postma in Amsterdam in 2008, to help people fix their products, to raise awareness of waste and to reduce product waste to landfill. In 2011 it became a non-profit organisation -The Repair Café Foundation - set up to provide professional support to local groups across the world in establishing their own Repair Cafés (www.repaircafe.org).

Restart[2] is a London-based social start-up facilitating repair projects and community based initiatives on circular economy and citizen advocacy (The Restart Project 2013). It is perhaps a growing reaction to 'the throw away society' (Packard 1960) that engagement in activities of repair and requisite skills development is on the rise. On-line information resources are growing in popularity with YouTube 'how to' videos on product repair and free repair guides and product information from websites such as iFixIt.

In their second global survey of repair cafes, Charter and Keiller report that the five categories of items most frequently brought to the Repair Cafés for repair include: Small Kitchen Appliances, Household Appliances, Lighting, DVD/CD Players and Clothing (Charter, Keiller 2016). Electronic goods are therefore a clear focus of repair activities with requests for repair non-electronic products, such as bicycles, in decline.

In this research people were interviewed about product care and repair project in repair cafes and other makerspaces. A criticism of this approach is that the people attending these events are already, by default, pro-repair. This bias is recognised in the research, however it does not affect the nature of the interview data in that the aim of the process was to undercover motivations for repair and the types of activities that constitute repair; it was not to seek a representation of what a general population understands the value of repair to be. Although the majority of interviews do involve participants at repair cafes or similar settings, a proportion of interviews were undertaken with the general public to take a 'thermometer reading' if you like of their perceptions of product brokenness and attitudes to repair.

This survey included a small number of semi-structured interviews that were carried out between May and July 2016. A key purpose of the interviews was to understand what constitutes brokenness and repair and to find out how people engage in the repair process. In total 41 interviews were completed: 10 were visitors to the Farnham Repair Cafe[3] and the Guildford Repair Cafe[4] bringing their products to be repaired; 16 were volunteers at those Repair Cafes or members of other Makerspaces (The Restart Project in London and Men in Sheds[5] in Milton Keynes); and 15 were members of the general public local to Cranfield University and Milton Keynes. The data from interviews were coded and a research ethics procedure outlining data use issues was discussed with each interviewee. It was found that people were generally happy to discuss their products and stories of repair. A summary of repair cafe respondents' motivations and barriers to repair is presented in Table 1.

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[2] RESTART is a London-based charitable incorporated organisation (CIO) aimed at fixing peoples' relationship with their electronic products. (The Restart Project, 2013, https://therestartproject.org).

[3] Farnham Repair Cafe - https://www.facebook.com/FarnhamRepairCafe

[4] Guildford Repair Cafe - https://www.guildford.gov.uk/repaircafe

[5] Men in Sheds - was launched in March 2012 with the support of Age UK Milton Keynes. The organisation provides an opportunity for older men to meet together and engage in different activities (e.g. woodworking, metal work and model making) and exchange skills.

Motivations and barriers to product repair			
When is a product considered to be broken?	What makes something worth repairing?	Why don't you repair it yourself?	What are the main barriers for repair?
- When it doesn't work as it used to - When it no longer can do what it was bought for - When the main function doesn't work anymore - When it is no longer convenient to use - When it stops working or doesn't work well - When the quality and performance decreases	- A product with emotional attachment that you want to keep - A familiarity with the product and technology - Better to repair than replace with a product you don't understand. - Cheaper to repair than replace - Cheap products are not worth paying repair for	- Lack of knowledge - Lack of time - The inconvenience of repair - The ease of buying a new product - Not owning the right tools - Concerns about voiding the warranty - Concerns that product won't work anymore - Lack of creativity to do repair - Lack of skill	- Lack of access to spare parts - Obsolete components - Lack of knowledge about the spare parts required - Products are not designed for longevity or repair - Products designed for manufacture, not disassembly - Difficult to open products to repair them - Products not looked after, are seen as disposable

Table 1 Repair cafe participants' views on product repair

Perceptions of brokenness varied but most respondents referred to a loss of function or a decline in the performance of the product that no longer meets the expectations of the user. Poor product performance was similarly highlighted in a study undertaken by Nottingham University (Salvia, Cooper, Fisher, Harner & Barr 2015). This study looked at why vacuum cleaners were replaced, and found that it was often also due to a decline in the performance of the product, and specifically the reduced power of the vacuum suction: a problem that can be easily remedied by cleaning or replacing the filters. Instead, many owners chose to dispose of the product and purchase a new one. Further examples of comments made by survey respondents that highlighted issues of product care and repair are shown in Table 2.

People don't treat things well as they don't expect them to last long
People don't take things apart anymore. They don't give the proper maintenance to their products. They don't even know how.
Glue also makes it difficult to take components apart. It is sloppy work but cheap to produce. Some products also use proprietary screws that make it impossible to disassemble. That is why they don't give you warranties.
Products are not built to last. People bring things to get repaired when they don't work how they're supposed to.
Products fail usually because of lack of maintenance, wear and tear.
When people have made or repaired a product they take more care of it.

Table 2: Interviewee comments on product care and repair

Heiskanen (1996) discusses that people replace products because of technical failure, dissatisfaction or a change in their needs. Similarly Granberg (1997) argues there are two types of obsolescence: absolute obsolescence (technical failure) and relative obsolescence where user expectations change with the availability of new product options. However he also acknowledges that behind this simple classification of obsolescence is a complex set of relationships between owners and their products, technological trends, and the economic and cultural contexts. Cooper (2004) creates a conceptual framework that begins to recognise these complexities. He describes three types of obsolescence: psychological, economic and technological. Here psychological obsolescence occurs when the user no longer feels satisfied with, or attracted to the product because their needs have changed, or they are persuaded to want something else (e.g. by marketing or a changing product aesthetic). Economic obsolescence arises when the financial factors make the product unviable (e.g. low performance, value reduction, repair costs). Finally, technological obsolescence occurs when the functional qualities of the product fail or are inferior to newer models. A decrease in product performance is viewed in this classification as part of 'economic obsolescence' but appears, from our interviews, to be a little more complex than a comparative value measure. For those attending repair cafes it is a primary factor that influences the user's decision to dispose of a product. A lack of maintenance and general care across product-life are key reasons why product functionality decreases below acceptable levels and users seek alternative solutions. Lack of product knowledge and lack of technical information about the product and its spare parts also play an important role in this decision-making process. A product's useful life can be largely determined by the treatment given to it during use (Gwilt, Leaver, Fisher & Young 2015). Most of the time the users lack interest in doing maintenance for the products they own, creating an obstacle to extending product life span (Salvia, Cooper, Fisher, Harner & Barr 2015).

Another strong theme from the interviews was the relationships people have with their product. Sometimes it's an emotional connection (Chapman 2005) - a gift from someone special; a product passed down through the family; a comfortable chair; a favourite dress. Other times the attachment is more pragmatic. One elderly lady explained how she much preferred trying to fix her products (she'd brought a number to the cafe already) because she was familiar with how the product worked - what all the buttons do (or the ones she needed to know about), and she didn't want to consider having to think about all that again with a new product using new technology.

Community based repair initiatives alongside on-line fixit instructions and Makerspaces have provided a new type of platform for people to seek out information to help them make decisions about extending their product's life. Not only do such repair initiatives contribute to waste reduction and product longevity, but they also provide places for people to socialize, share and learn new skills (Kohtala 2015; Prendeville, Hartung, Purvis, Brass & Hall 2016), as illustrated by some of conversations at the repair cafe in Table 3.

[a repair cafe visitor] ***"I am not creative or knowledgeable enough to do repair."***
The same person explained that she'd had lots of positive experiences at the repair cafe and trusted them to do a good job. She wants to bring a bicycle in the future and to keep mending products because it's cheaper than having to buy new ones.
[a repair cafe volunteer] ***The volunteers all share their skills. Once another volunteer was fixing a sewing machine and needed her input as she knew exactly how it should work. She feels it is better if there is another volunteer on your table (different expertise per table e.g. sewing, bike repair, mechanical products, electronics) with you looking at repair problems as you can work together to think what the best solution would be.***
[a repair cafe volunteer] ***The original manufacturer put a faulty switch to a kettle. I went online to get the replacement and there were so many options ... sometimes it happens that people just don't know which is the correct spare part to buy. They don't repair because they lack the knowledge. That's why they come here.***
Stuff isn't built to be repaired. Older products are easier to get into. Newer products are hard to take apart.

Table 3 Comments on skills and knowledge at the Repair cafe

Repair cafes and similar Makespaces attract people who have a positive view of repair. To collect other perceptions on repair a further 15 interviews were conducted with members of the general public. Interviewees were asked to tell a story of a product that had broken and discuss whether they replaced or repaired it. They selected a range of products, from small kitchen goods such as a toaster, food processor and a grill to more complex products like laptops, phones and a play-station. Nine respondents had bought a replacement product when theirs failed, and, in general, their common response to product failure leaned towards product replacement. Two respondents had had their products fixed under warranty; one of these then failed again outside the warranty period and at this point the respondent asked her father to fix it which he did. Two respondents successfully repaired their products, one using an expert, the other by himself using on-line 'how to' guides to provide information. Two other respondents had products repaired but they subsequently failed. Both of these were done by self-repair: one ended up purchasing a new bike component; the second resulted in a subsequent component failure after a couple of weeks of successfully fixing the first. At this point the respondent bought a new razor frustrated that he had wasted his time and money on the first repair.

The survey data produced a range of repair narratives describing repair and product life. In the final section of this paper we connect these findings to business strategies geared to slowing resource loops and the circular economy.

Creating a landscape of repair

Narratives of repair activity have highlighted the importance of product durability: both in terms of product quality, function and robustness and also in terms of endurability -the relationships people have with their products for multifarious reasons. For meaningful, durable products to be created, customers need to take an active and integral part in the design process (Kohtala 2015; Prendeville, Hartung, Purvis, Brass, & Hall 2016; Sahni, Khan & Barad 2015). Engaging customers in the design and development of products to generate different, perhaps personal, product attributes enhances their relationship and attachment to these products (Mugge, Schoormans & Schifferstein-Hendrik 2005). Customers' needs may be met in entirely new ways through creating hybrid models of production where co-design occurs between customers, local makerspaces and manufacturers and where new product experiences and communities can be connected and informed (Sanders 2008).

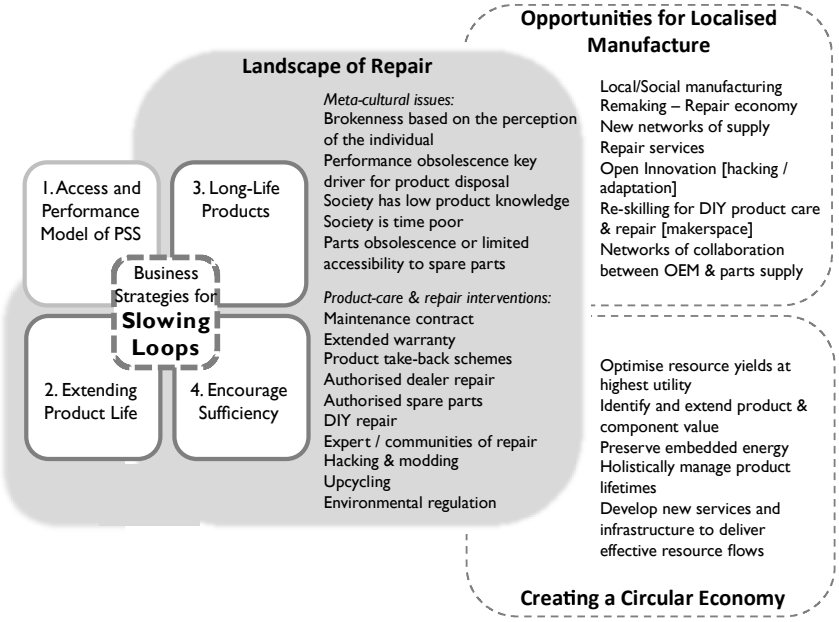

Figure 3 Strategies for sufficiency in a landscape of repair

(Based on the Business Strategies for a Circular Economy described in Bocken, Pauw, Bakker & van der Grinten 2016)

Longer lasting products coupled with a culture of repair provide an interesting backdrop for circular economy business strategies. New configurations between circular business models and design strategies will create circular design strategies that not only extend product life but also revision the role of the product for different modes of consumption (Moreno, De los Rios, Rowe & Charnley, 2016). Bocken, Pauw, Bakker & van der Grinten (2016) identify new business models to drive innovation and change the "dominant business model logic" to move to a circular economy model. The circular economy is, they state, an example of radical change that requires a new way of thinking and doing business. Figure 3 presents these four business model strategies for slowing resource loops. The first, access and performance, addresses the capability of services to satisfy needs without product ownership. We focus less on this strategy in linking the framework to user-centred repair as it is primarily concerned with business models to maximise the utility of product function through exploring new modes of product use e.g. leasing and shared ownership. While user behaviour plays an important part in the overall effectiveness of these business models, issues of product maintenance and repair are the responsibility of the owner and not the user. The second strategy focuses on realising the residual value of product resources across the produce-use-reuse cycle and links to remanufacturing and product take-back. The third strategy focuses quality for effectively delivering long-lasting products. Finally the fourth strategy broadly explores sufficiency as a driver for less resource consumption. Strategies three and four are particularly reliant on creating a culture of longer-life and repairable products. Figure 3 shows the slowing down of resource flow through strategies of product repair and localised manufacture. It links the business strategies for achieving a circular economy (Bocken, Pauw, Bakker, van der Grinten 2016) to the knowledge of, and motivation for, activities of repair generated from the survey data and from the broader literature. The strategies and the landscape of repair that has been suggested are then connected to concepts of localised manufacture (with characteristics that support product repair and durability) and the requirements for the development of a circular economy.

In this context an efficiency driven model alone has proved ineffective at creating sustainable business strategies. Obsolescence, in its many forms, can only be successfully addressed if a greater emphasis is placed on strategies of sufficiency alongside those already addressing efficiency. We suggest, from this small survey of user-initiated repair activities, that product repair and all that this involves, is a fundamental part of any business strategy that links people and their products to the slowing and closing of resource loops. In order to realise this however companies will need to design ‘repairable’ products, and engage users more effectively in the design of these products. By doing so, they can create lower barriers to repair, and form new relationship with customers – creating new opportunities for circular consumption and production in the long term.

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