

Designing Circular Possessions

Exploring Human-Object Relationships in the Circular Economy

By

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Abstract

This thesis argues the need for a fundamental shift from the design of products to the design of possessions in the circular economy. Possessions in the circular economy are characterised by interactions resulting in a user-object relationship rather than legalese and differ from the linear economy in terms of their length of use and number of users. Individual users are thus seen as critical actors to enable material circulation in that they take possession and dispossess of products. Two key topics—psychological ownership and contaminated interaction—are explored in detail to fill theoretical gaps in design research and practice. After discussing these topics, some directions and guidelines are suggested.

Possession or ownership is taken as an innate human desire. A framework describes the method of developing ownership including the motives, routes, and paths that guide the development of that relationship. This framework is used to describe object attachment to inform product longevity and decisions around keeping and discarding. It is also useful to help explain why some access-based models are adopted while others are not.

Maintaining perceived value in the circular economy entails mitigating contaminated interaction—tainted interaction due to prior use and prior users. Contaminated interaction is shown to affect new circular business opportunities, disposal decisions and downcycling. A typology is presented to characterise indicators of use with an emphasis on sensorial material properties. Aversion to used products is found to come from three drivers: hygiene, utility and territory. A theoretical framework for contaminated interaction is presented which is explored through positive and negative forms of contamination. Finally, a case study shows how alterations in product characteristics lead to improper disposal and act as an example of what it means to design of circular possessions.

Declaration

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March 2017



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List of Publications

The following publications have resulted from this work at the time of submitting this thesis.

Refereed Journal Papers

Baxter, W. L., Aurisicchio, M., & Childs, P. R. N. 2017 “Contaminated interaction: another barrier to circular material flows,” *Journal of Industrial Ecology*. 21, 507-516. Available from: doi:10.1111/jiec.12612

Baxter, W.L., Aurisicchio, M. & Childs, P.R.N. (2016) Materials, use and contaminated interaction. *Materials & Design*. 90, 1218–1227. Available from: doi:10.1016/j.matdes.2015.04.019.

Baxter, W.L., Aurisicchio, M. & Childs, P.R.N. (2015) A psychological ownership approach to designing object attachment. *Journal of Engineering Design*. 26 (4–6), 140–156. Available from: doi:10.1080/09544828.2015.1030371.

Refereed Conference Publications

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Baxter, W. L., Aurisicchio, M., & Childs, P. R. N. (2016). Exploring a human-centred design of possessions. Paper presented at NordDesign 2016, Trondheim, Norway.

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Conference Abstracts

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Book Chapters

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1. Introduction

John Steinbeck's *The Grapes of Wrath* opens with the grievous tale of Oklahoma dust bowl farmers who are forced from their homes during the Great Depression. When asked to vacate their properties, the tenant farmers stand in protest and confront the bank representative that owns the land. "...but it's our land. We measured it and broke it up. We were born on it, and we got killed on it, died on it. Even if it's no good, it's still ours. That's what makes it ours—being born on it, working it, dying on it. That makes ownership, not a paper with numbers on it." To this, the bank representatives explained that they have no choice. The orders were not coming from them—they were passed down from the bank (Steinbeck, 1939). The problem faced by the tenant farmers lie in the juxtaposed nature of ownership. The farmers *felt* the land was theirs. After all, they took care of it and had lived on it their whole lives. The bank, however, was the legal owner and as such was interested in maximising profits. The result is a type of hybrid ownership in which two entities each have some kind of ownership claim over the same object (Linklater, 2013).

Unlike the bank, companies typically benefit from engagement in their business—buying goods and using services—and can't simply dismiss customers or drive them away. Creating positive engagement comes from understanding the user's relationship with objects that surround them. Like the farmers, this relationship is often underscored by a fundamental concept of possession that mediates and moderates how people interact with their surroundings. In a basic sense, objects move in and out of a person's possession regardless of ownership. However, as Frank Snare notes, the meaning of possession is deeper than that: understanding possession is a prerequisite to appreciate the meaning behind common interactions such as selling, gifting, buying, barrowing and stealing (Snare, 1972). Companies

interested in creating user value then benefit from focusing offerings on a human perspective of possession, not just operational logistics and business model configurations. What then does it mean to possess something from a human perspective and how do companies facilitate this? Being able to answer this question is increasingly important under new interaction paradigms.

An example of the importance of taking a human-centred perspective of possession made international headlines in 2014 when Apple teamed up with the band U2 to gift an album to 500 million iTunes users. The idea was simple; Apple would purchase the album from U2 and distribute it to users free of charge. Despite any good intentions, there was a fairly severe backlash from many users (Peterson, 2014). The backlash seemed to stem from the idea that Apple had infringed on what users felt was theirs since Apple had pushed the album into users' digital libraries regardless of whether users wanted the album. Slate magazine called Apple's move a reminder that music belongs to Apple as much as it does to us if we are to use iTunes, and that "consent and interest are no longer a requisite for owning an album, only corporate prerogative" (Wade, 2014).

What role do possessions take if we move beyond a discussion of a new medium—physical to digital—and talk about a whole new economic model? The circular economy seeks to develop value by disrupting the linear take-make-dispose model of consumption into one in which material remains in the system and is utilized to a high standard. On the logistical side this is achieved through processes like product maintenance, reuse, remanufacture and recycle which prevent material from going to landfill (see Figure 1-1). From a human-side, this requires new (or altered) business models and products, services, and human interactions those models comprise. Like the iTunes example, this changing landscape requires that we take a step back and re-examine people's relationship to the object's they use—their possessions.

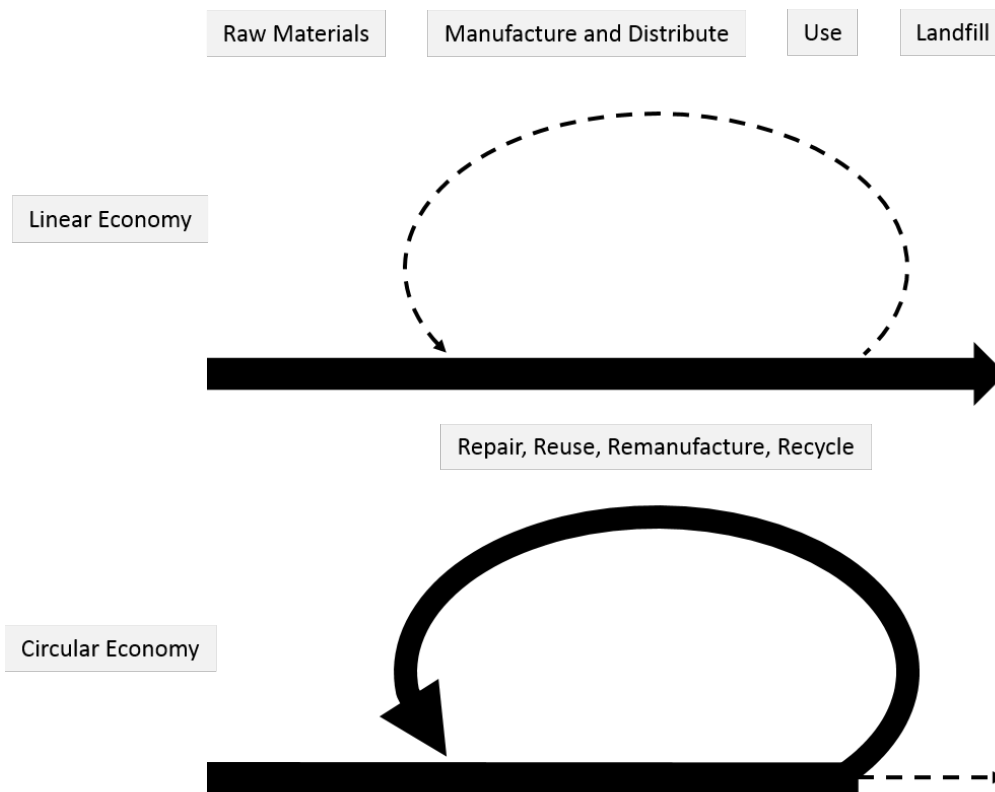


Figure 1-1 Contrast of material flows in the linear and circular economies

1.1. The Aim of this Thesis

This thesis explores human-object relationships in the circular economy in order to better understand how to put people back at the centre of designed offerings. This is a response to recurring issues with offerings intended for the circular economy that reflect logistically centred, rather than human centred, thinking. For instance, in the circular economy, a company may retain ownership of a product and offer an access-based consumption model where users temporarily use the product before returning it again for someone else to use. Examples of this are seen in the growing interest in car, toy, bike, and tool sharing programs. These access-based consumption schemes require that users give up ownership—a task that has been shown to be difficult at least in part because those designing the offerings do not fully understand the intangible value associated with ownership (Tukker, 2013; Tukker and Tischner, 2006). Other companies are concerned that products will be treated more harshly if a person no longer feels a sense of ownership for the products they are accessing. Once returned, another issue arises. Products are often seen as tainted and unsuitable for reuse

without at least some degree of intervention. This is true of reused goods as well as remanufactured products (Baxter et al., 2017a). Finally, many of these offerings gather various data on users and products leaving an ongoing discussion around whose data that is. Thus, while this approach makes sense logistically, the broad issue is understanding how product-level value is created and maintained for users within the circular economy and how this influences material circulation.

The overarching argument for this thesis is the need for designing circular possessions—products that move in and out of a person’s possession that effectively transfer within the larger circular system. The central aim of the research in this thesis is then to provide needed understanding around the user interactions in the circular economy central to successful material flow. The fulfilment of this aim is achieved by:

- Positioning users as central and essential participants in the circular economy who take possession, possess, and dispossess of material (e.g. products) and thus are integral to material flows.
- Developing understanding around the value that users gain through (psychologically) owning things, the impact this has on relevant behaviours and how this can be influenced through design processes.
- Creating new knowledge around how perceived value becomes tainted as products are circulated across multiple uses and between multiple users and how design can start addressing such contaminated interactions.

The result of this work is a bridged knowledge gap around how to create positive user experiences while achieving system-level objectives. Thus, this work explores the human-object relationships in the circular economy in order to better allow designers to influence these relationships to create meaningful interactions with circular business models, products and services. The topics explored in this thesis offer broad understanding to clarify direction for design research and practice. Future work should examine detailed issues contained within each of the sections explored.

1.2. A Circular View of Possession

Within this thesis, the circular economy is broadly understood as a system in which resources remain in use as long as possible, have the maximum value extracted from them during use,

and are recovered at the end of each service life (WRAP, 2013). In its fully imagined form, the circular economy necessitates that all linear processes be adapted or replaced to be circular. Within these processes are numerous consumer behaviours that will also have to change or which now become central concerns. A lack of understanding around these behaviours is one hurdle to more widespread adoption of the circular economy (EMF, 2013a). This becomes evident in consumer-facing business models in which a person plays a key part in the flow of resources through the acquisition, usage and return of goods.

In this sense, circular possession is centred on an understanding of when and how someone (dis)engages with a product and how this influences the product's ability to be circulated within the system. This is a clear diversion from the linear economy whose interest diminishes exponentially at the point of sale. But what if a product was not thought of as being bought but as being possessed by a person for a period? During that time in which a person possesses the product they have a specific relationship with it but it will eventually be dispossessed and returned to the system. This type of thinking would influence how products, services and interactions are conceptualized and actualized. Sure, people need to acquire things (purchasing, borrowing, using, or however else) but if resources are to be circulated we also care about how things are used and how they are returned to the system, not tossed in the bin. Designers focused on circular possessions are then concerned as much with the last interaction as they are with the first.

This definition of possession is much broader than what is typically considered. Of course, possession includes those purchased goods that fill up our homes. These traditional goods follow a well-established path of entering and exiting our possession but what of things that are temporarily used and somewhat generic in nature. These too are possessions. After all, we still call it *my* hotel room, *my* rental car, or *my* library book though we have legal access but not legal ownership over these things. Possession is then semantically centred on the human-object interaction in its entirety (first engagement to disposal) and not just a piece of it. Termed as such, we are forced to move towards lifecycle thinking in how people interact with things.

Circular possessions differ from traditional ownership in two dimensions, see Figure 1-2. First, circular possessions require stronger consideration about the length of use. Whereas

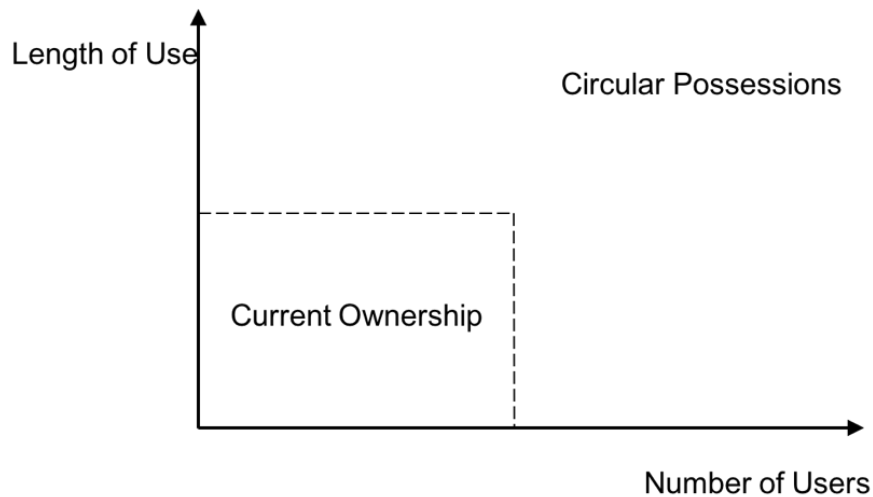


Figure 1-2 Two dimensions in which circular possessions differ from current ownership.

traditional ownership is primarily interested in how a person interacts with a product up until the point of sale, circular possessions are concerned with interactions that take place through to the point of dispossessing the object. This type of thinking includes how long a person keeps an object, how they use it during use, and what they do with it when dispossessing. Included here is also concern over increasing the technical and emotional useful life of a product. Second, current ownership typically occurs with a single person interacting with a product or a product being shared amongst a small group such as family or friends. Belk (2010) differentiates sharing from access in that sharing is about joint ownership in which an object is free for all to use without generating debt while access is also not necessarily altruistic or prosocial¹. In this case, sharing is more typical of traditional ownership and circular possessions are about many people engaging the same object as it is reused, remanufactured or recycled. These dimensions require a fundamental shift in thinking about human-object interactions. Consider the following examples of circular possession thinking.

The bag pictured in Figure 1-3 was a gift given to me new years ago. I love the bag and have consequently cared for it and repaired it several times when parts have broken. Strapped for cash and space as I moved countries to start my PhD, I decided to sell the bag. I listed the bag online and shipped it to the highest bidder—a woman who thought it would be perfect as a

¹ With this understanding, the sharing economy is most often about access. Within this thesis, any reference to the sharing economy or sharing refers to access unless otherwise stated.

gift for someone she knew. A few weeks after I shipped the bag it was returned to me with a note that said, “The bag is beautiful but it looks too used. It is too much *yours* to be able to give it to another person.” For me, this represented a strong circular possession. I kept it in the system several times by repairing it when it had broken and have used it for several years. When there was a chance to sell it I also wanted to keep it in the system and tried to sell it online



Figure 1-3 A leather bag as a circular possession

rather than disposing of it as waste since it still carried a lot of value. However, this was an issue as my use had prevented another person from wanting the bag.

Several design questions emerge from this experience in terms of circular possessions. How might we design products that appreciate over time and provide sustained positive experiences to people? How might we design products that are so meaningful that people will want to repair them when they break? Finally, how might we design products that maintain the ability to provide positive experiences as they are transferred between users?

Now consider a very different scenario reported by Robert Garson—a New York City-based attorney and a member of the car-sharing community (Garson, 2016). Mr Garson and his wife had loaded their children into the shared car and were heading out for the day. His wife reached to put her seatbelt on and noticed a vial of white powder in between the two front seats. Drawing on his years as a barrister in England where he defended serious crime, he concluded the vial was filled with cocaine. Admittedly, this was an assumption but, as Mr Garson points out, it highlights a larger issue. What do you do if you find something illegal in a shared car? Neither car sharing companies nor law enforcement are likely equipped to properly handle the situation. Any conversation with law enforcement is not likely to go over well. “But officer, I swear those are not my drugs. I have never seen that before.” Words spoken by every guilty party. As the adage goes, possession is nine-tenths of the law.



Figure 1-4 An example of a Zipcar similar to the one Mr. Garson would have used. Source: www.zipcar.com/press/photos

Was this a circular possession? The model of car sharing is by its nature a circular process in which a single product is used much more than it may otherwise be if it were owned by a single person. Car sharing has also been heralded as one of the darlings of the sharing economy (Botsman and Rogers, 2010). It is also a possession. The title of Mr. Garson's article—*My Zipcar Had a Vial of Coke in It*—and the fact that he was nervous about being in possession of a narcotic suggest he felt it was his in a very real way. Clearly, this also highlights an issue in the conception of what possession means in circular business models. Sure, possession exists with temporarily accessed goods but the nature of possession fundamentally changes in the eyes of the user, the company, and larger system processes (i.e. the law). Like the last example, Mr. Garson's experience also highlights issues around products being transferred between multiple users.

Finally, consider one of the most basic products—a disposable coffee cup. In the UK, billions of these cups are used every day. Once purchased, the possession of the cup shifts from the company to the consumer along with the stewardship to deal with the cup properly. Ideally, if such cups are used they would be recycled so they can remain in the system. Indeed, many cups have a recycling logo on the cup as if to signal it is recyclable. Unfortunately, most recycling facilities are not equipped to deal with these cups given the laminate coating that

interferes with the paper recycling. The result, at least in the UK, has been a bit of a coffee cup row in which conscientious coffee consumers felt that the coffee chains had misled them into thinking the coffee cup is recyclable where in reality less than one percent of such cups get recycled (Rustin, 2016; Webster, 2016).

In this example, many consumers are ready and willing to engage in circular practices by sorting the cup as recycling but the cup itself is not recyclable. While users do have possession of the cup, the cup itself is not designed to be a circular possession since it cannot return to the system as it is currently made with the given infrastructure within which it resides. There may be a second issue of possession here. When people *feel* a sense of ownership for a product, they often have a stronger sense of stewardship for the product (Hernandez, 2012). This is likely true for products as simple as coffee cups as well. As one study shows, recycling rates of coffee cups differ when a person's name is spelt correctly on the cup (Trudel et al., 2016a). Thus, if a cup reflects a person's identity more strongly and subsequently is felt to be a stronger possession, it will be recycled more. This example highlights the importance of understanding circular possessions in terms of how they fit within the system and how the user relates to the product in question.



Figure 1-5 A common coffee cup

1.3. Circular Possession as a Design Principle

This thesis is intended to lay foundational understanding that will help guide design decisions around business models, products and services. The approach in this thesis is to better understand how value is created and maintained in the circular economy for individuals and the boundaries in which such value should be considered. The frame of circular possession is intentional for the semantic shift it encourages. The emphasis on circular shifts designers to think about lifecycle considerations. For instance, how does the design of this product influence end-of-life disposal decisions and ultimately influence material flows? This integrates people into the circular economy as actors who play an important role in the development of circular systems and deserve to be treated accordingly. The focus on

possession places the design focus on the entire experience a person has with a given product, not just the purchasing experience.

This work is fundamentally about providing a good user experience (UX) within the circular economy. Don Norman and Jakob Nielsen define user experience as “all aspects of the end-user’s interaction with the company, its services, and its products” (Nielsen and Norman, n.d.). This definition requires a slight change under the circular economy since we are interested in following the person’s interaction with a product which may span across several company jurisdictions. For the purposes of this thesis, the user’s experience with a product is examined as it relates to the end-user’s interaction with all companies, services, and related products between which the product moves. This includes the perception of the product as well as the ease with which the person uses the product and returns it to the system.

Taking this human-centred approach to designing possessions, Figure 1-2 can now be expanded to include the experience designers should seek to provide with circular possessions, see Figure 1-6. A product that maintains a positive user experience throughout the length of use provides durable user experience. Products that maintain positive user experiences as they move between multiple users provide resilient user experience. Importantly, these are often not achieved together. For instance, the bag discussed in Section 1.2 was durable during my use but did not easily transfer to other users. It is acceptable to achieve either durable or resilient experiences separately so long as the design of the larger system makes up for this. The ideal, however, is to achieve both. When a product provides durable and resilient experiences it is thought to be experientially transferrable (Baxter et al., 2017a). Each is described in more detail below.

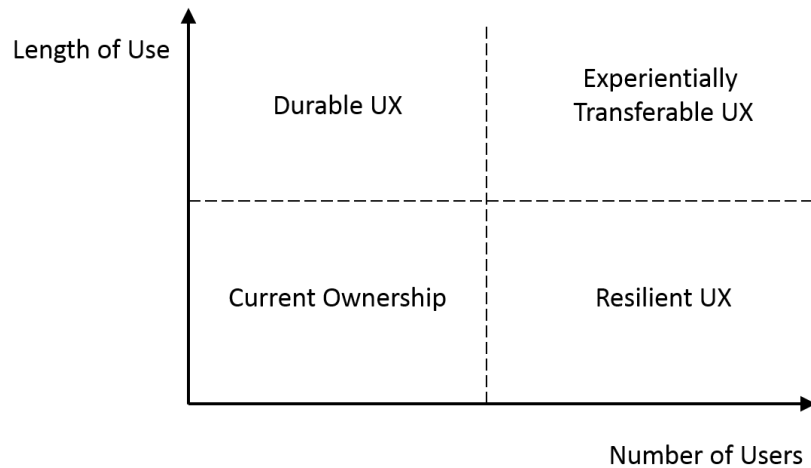


Figure 1-6 Durable, resilient and experientially transferable user experience.

Durable UX

The successful circulation of material flows requires that we consider the possession life cycle of products—how they enter use, get used, and are discarded. Ensuring that the user experience throughout this life cycle is durable consists of two parts. First, increasing the use stage of a product is important to extend repairing or maintaining a product to keep it in use. Durability as it has been typically considered in terms of altering an object’s physical characteristics is not enough. Instead, as Jonathan Chapman has promoted, these products need to be designed to create emotionally durable experiences (Chapman, 2005). Staying most true to Jonathan Chapman’s work, Durable UX is about designing products whose value does not diminish over time. That is to say that products designed in the circular economy are fundamentally about enhancing the user-object interactions over time. This includes enhancing the physical characteristics of a product so they wear well but it is also about considering the attachment that develops over time.

The second part of Durable UX is that of ensuring a positive experience throughout use. Just as great care goes into understanding how users perceive, and interact with products at the point of sale, designers need to focus on how people perceive and interact with an object while using and dispossessing it. Circular possessions should create as positive a user experience at the end of a product’s life as it does at the beginning. Durable UX should take a human-centred approach to understanding why and how people make the decisions they do and how this can be as positive as possible.

Resilient UX

As material becomes circulated in the system it will transfer between users at an unprecedented rate. This may include a relatively quick transfer of products to other users as seen with renting or other access-based consumption models. It may also occur following a lengthy process of refurbishing, remanufacturing or recycling. Either way, the meaning and value of the product may change as it transverses these categories and extra care should be given to understand how it can maintain value as it moves between users. Products that offer positive experiences as they transfer between users offer a resilient user experience. Resilient UX is about recognizing interpersonal factors that taint subsequent interactions and designing methods to mitigate this.

Transferrable UX

When a product is both durable and resilient it is thought to offer a transferrable user experience. This is the ultimate goal within the circular economy as all products need to be returned to the system and all will also be used by multiple people in some part of their lives. While there are numerous examples of products that are successful at providing either durable or resilient experiences, transferrable experiences are less common.

One illustrative example of Transferrable UX exists with car sharing. Personal cars often come with two sets of keys. The settings established in a car is associated to a particular key and each time the key is used the mirrors, radio, seat position and other settings automatically adjust for the rider and their corresponding key. This situation is durable in that each time the user gets in the car they likely develop a stronger relationship to the car as they get to know it more intimately and invest time and energy in the car. The car also has some resilience in that the car remembers initial settings and adapts to the user to make any transition between users as simple and meaningful as possible.

1.4. Overview of this thesis

The main contribution of this thesis is in addressing gaps in circular economy thinking. Thus, the primary body of work this thesis contributes to is the circular economy design and business community. This community is quickly growing and brings together a range of related research areas. This thesis draws on work from these related research areas but is positioned to cut across such areas given the wide theoretical constructs it furthers. Likewise,

this thesis is not positioned in any specialist area but contributes thinking to several areas of research. Most broadly, the work helps inform what it means to create meaningful experiences within the circular economy and thus contributes to the field of user experience. Additional contributions are made to the design for sustainable behaviour community in the form of describing motives and drivers behind many (un)sustainable behaviours in the circular economy. The thesis also contributes to a growing amount of work carried out around psychological ownership. Much of the psychological ownership literature focuses on marketing and organisational behaviour issues whereas this thesis contributes a perspective from design. Finally, specific studies within the thesis contribute understanding to research categories such as materials experience and the sharing economy.

As noted in Section 1.1, the aim of this thesis is to provide needed understanding around the interactions in the circular economy central to successful material flow. This chapter has laid a foundation for addressing this aim by reframing products in the circular economy as circular possessions. Chapter 2 continues the discussion of reframing users as possessors which is a theme that continues throughout. The remaining chapters address a set of objectives related to developing new understanding around the concepts of ownership and contaminated interaction. An overview of the thesis is given in **Error! Reference source not found.** and a short description of each chapter is provided below.

Chapter 2 examines the roles of the user in order to enable circular material flows. Here, users are acknowledged as key contributors to successful material circulation. Those behaviours critical to the success of the circular economy are identified and grouped broadly according to the process of taking possession (i.e. acquiring), possessing (i.e. using), and dispossessing (i.e. disposing) of a product. Importantly, this broadens the definition of possession as it includes things temporarily possessed (e.g. those things rented). This informs what it means for a user to become a circulator.

Table 1-1 Thesis Overview

Section	Chapter	Objective	Key Contribution(s)
Introduction	One	Introduce the concept of circular possessions	New human-centred frame for designing in the circular economy
Circular Possession	Two	Investigate the role of the user in the circular economy	List of six behaviours critical to user-facing material circulation (Review)
	Three	Understand of why and how people feel possession for an object	Theoretical framework of the motives, routes, and other factors contributing to possession (Study 1)
	Four	Assess the behavioural consequences of possession	Ownership describes object attachment (Study 2) and decisions to keep or discard things as well as engage in access-based models (Study 3)
Contaminated Interaction	Five	Distinguish various types of contamination and how they impact circularity	Identification of three types of contamination (technical, systemic and interaction). Contaminated interaction can lead to hindered circulation, downcycling and disposal (Study 4)
	Six	Develop a foundational understanding of contaminated interaction	A typology of indicators of use (Study 5) and an ontology to describe contaminated interaction (Study 6)
	Seven	Demonstrate how product-level decisions impact material circulation	Understanding regarding how product attributes influence recycling (Study 7) and littering (Study 8)
Discussion and Conclusions	Eight	Present conclusions from the thesis and suggest future research	Insights from the studies and directions for future work

Chapter 3 expands upon a model for understanding the motives and routes behind the process of possessing. The chapter builds on literature and results from semi-structured interviews (Study 1) to present a human-centred, rather than legal-centred, understanding of possession. This informs relevant areas of the circular economy such as the adoption of product service systems or other access-based models.

Chapter 4 builds on the theoretical model presented in Chapter 3 to help explain consumer decisions around product longevity. Keeping, caring and discarding of objects are all a result of feelings of possession. Studies 2 and 3 show how an understanding of psychological ownership of products informs object attachment and ultimately can lead to decisions around keeping and discarding things. The work also provides further commentary on how the model of Chapter 3 influences decisions to engage with access-based consumption.

Chapter 5 explores how value is threatened in the circular economy and identifies three types of contamination: technical contamination which deals with fitness for use; systemic

contamination which deals with the purity of material flows; and contaminated interaction which deals with tainted behaviours or perceptions. Contaminated interaction is explored through case studies and literature and is found to act as a barrier within the circular economy (Study 4). Specifically, contaminated interaction leads to hindered material circulation, downcycling, and disposal.

Chapter 6 explores contaminated interaction through two studies. The first study (Study 5) seeks to understand how people perceive use. In other words, what indicates that an object has been used? A resulting typology is created and linked to sensorial properties of material. This knowledge is useful in assessing user evaluations of used products and a starting point to address how things are seen as used. The findings are then evaluated for instances in which perceived use leads to diminished perceived value. This results in the HUT (hygiene, utility, territory) model of contamination to understand the fundamental drivers of contaminated interaction. Study 6 develops a theoretical foundation for design explorations into contaminated interaction. The study draws on literature and reported cases of contaminated interaction to develop an ontology. This widens the overall conception of contaminated interaction and presents it as a design concept.

Chapter 7 brings together the lifecycle thinking needed in designing circular possessions and the results of contaminated interaction. Specifically, product packaging is explored through two studies to show how alterations in the packaging can lead to drastically different rates of recycling and littering. Study 7 shows how changes in common recyclables (e.g. paper, cans) lead to subconsciously miscategorising recyclables as waste. Study 8 is a field study that considers how the same type of physical changes to an object can lead users to litter objects more. These studies highlight how designing circular possession must consider the entire product lifecycle and how early design decisions can influence how a product is kept in use. This brings together findings from the first and second parts of the thesis. The design of packaging should be thought of as designing a circular possession as its meaning can change through use and can lead to improper disposal. Thus, if considered in an entire life-cycle approach, this would likely be addressed as a design decision. The chapter also highlights a specific case of contaminated interaction as it influences material flows where the changes in packaging lead to altered and undesired interactions.

Chapter 8 presents an overall discussion of the research and a summary of key conclusions and contributions from this research. This chapter summarises what it means to design circular possessions and how this work has informed several directions deserving future investigation. Design guidelines emerging from the work are presented and the chapter ends with suggestions for future work.

2. From Consumer to Circulator: redefining possession in the circular economy

The Circular Economy is built on the idea of systems thinking which requires identifying and accounting for all constituent parts of a system and their interactions. This is reflected in the first use of the term *circular economy* which resulted from the observation that recycling was not built into the linear economy (Pearce and Turner, 1990). Since this first conception of the term, the circular economy has developed into a much more complex understanding of circular processes but the temptation remains to simplify circular processes and methodologies into discrete members rather than seeing the interactions within the larger system (Webster, 2013).

A seemingly neglected aspect of the circular economy seems to be a closer investigation of the role played by consumers. As James Moody explains: “While market signals are slowly aligning and technology factors are coming into place, the development of successful closed loop business models is still hampered by the lack of really good data on consumption behaviour” (EMF, 2013b p. 75). The focus on business operations rather than consumer behaviour may be attributable to the fact that organizations make a larger contribution to environmental problems than individuals and focusing on changing organizational behaviour could lead to greater results (Stern, 2000; Stern and Oskamp, 1987). However, as explained in Chapter 1, individuals are instrumental in the circulation of materials and a fully realised circular economy will only occur if greater focus is placed on understanding individuals’ role(s)

in the system. In this chapter, consumer possession is considered as the process through which individuals acquire, use and discard objects and thus play an integral part to the system.

2.1. From consumer to circulator

The transition to a circular economy requires new consumption habits to be successful and thus new role(s) for people within the system. Many see this as a transition from consumer to user. The idea behind this is that nothing is ever consumed in the circular economy, only used temporarily before being cycled into subsequent uses. This semantic shift helps reframe the part played by individuals in the circular economy. However, as others have pointed out (Kelly and Matthews, 2014), a focus on use and user can limit the breadth of understanding regarding the relationship a person has within a designed system. This is certainly true of the circular economy where individuals will undoubtedly take on several roles while acting their part in the circulation of materials in adapted or new business models.

There are differing opinions regarding individual-level engagement in the circular economy. Some posit that individuals should be informed participants in the circular economy and that an essential undertaking in the circular economy should then include activities such as raising public awareness (Liu et al., 2009; Xue et al., 2010). Others discuss desired behaviours in the circular economy and how design, marketing or other methods should encourage these (Mont, 2008; Zhang et al., 2011). This implies a different approach in which individuals are potentially ignorant in terms of their knowledge of a circular economy but are engaged just the same. This discussion of whether individual participation should be active or passive is secondary to a more fundamental question—what must individual actors do to facilitate the circular economy?

The individual-level transition can then be thought of as one that moves from consumer to circulator. As a consumer, one acquires an offering, uses up (i.e. consumes) its value, and is not integrated into post-purchase considerations. As a circulator one temporarily uses an offering before allowing the value of the product to remain in the system. A circulator is then a user who may take on several roles that are necessary to creating and maintaining value in a circular system.

2.2. Critical Behaviour in a Circular Economy

The first step in identifying the roles individuals play in the circular economy is examining which behaviours are critical to the circulation of material at the system level. It is not reasonable to attempt to identify all possible behaviours since the number and diversity of behaviour in the circular economy is just as complex and interesting as those in a linear one. Instead, we might consider behavioural types that occur in the three stage process of acquiring, using and disposing of products that characterise consumer behaviour (Jacoby, 1976). In other words, how and why do people take possession of things, use them during possession, and then dispossess of them? Through this approach, human interactions with any product, even if it is not legally owned by the individual, can be considered from the perspective of how they are possessed.

A review of Circular Economy literature highlights six behavioural categories important in the possession of products within the circular economy as summarized in Table 2-1. Acquisition is primarily about understanding purchasing behaviours and a willingness to engage in new business models. Usage places a focus on understanding consumption and about product care. Disposal is about understanding individuals' tendency to reuse objects and how they return objects to the system. Importantly, much has been done to understand most of these behaviours within the linear economy. Accordingly, the behaviours are presented as how they change in the circular economy and how additional research or understanding is needed to account for these changes.

Critical behaviours in product acquisition

How and why consumers or stakeholders acquire an offering is a central tenet to any venture and certainly those incorporating circular economy principles. It follows that one of the most significant hurdles to CE adoption lies in understanding the shift in acquisition behaviour. This section focuses on key acquisition considerations under the Circular Economy framework with attention to areas that may differ from the existing condition.

Acquisition normally occurs if perceived risk adjusted value of the product exceeds its selling price (Kalish, 1985). Literature suggests two ways in which acquisition changes under the CE framework. First, because products are intended to recirculate in the system, there will undoubtedly be product-level changes. These changes, such as altering materials and form,

may improve product durability or make the product easier to deal with at disposal but this also affects factors directly linked to customer purchasing such as price and perception. Second, the system surrounding acquisition changes. Traditionally, buying is the most common mode of acquisition and will certainly be influenced by the results of product-specific changes as just discussed. In addition to buying new products, the emphasis on repair, reuse, and remanufacture will certainly give rise to secondary or sharing markets at a scale never seen. This category is broadly referred to as adoption of (new) business models.

Table 2-1 Critical Behaviour in the Circular Economy

Behaviour	Description	Selected Examples
Acquisition		
Purchasing	Product-specific changes to enable better circulation of resources will likely change the cost and perception of an offering thus requiring an examination of how purchasing habits will change.	(Liu and Bai, 2014; Mathews, 2011; Ongondo et al., 2013; Su et al., 2013; Zhang et al., 2011)
Engaging in (new) business models	Moving from traditional purchasing to consumption modes such as sharing and access are convenient logistically but consumers are slow to accept these models. Ownership, contamination, and social factors need to be investigated further.	(Bakker et al., 2014; Liu et al., 2009; Mont, 2008; Stahel, 2013; Tukker, 2013; Yabar et al., 2009)
Usage		
Resource Consumption	Energy use, pollutant generation, and throughput of material are all important factors considered in resource consumption.	(Zhou et al., 2012)
Product Care (including repair)	The extent to which an individual cares for a product impacts durability during the usage stage and the ability to utilize the material post-use. Repair allows consumers to extend a product's life. Like factors influencing care, repair is highly driven by cost, ease, modernity, and product attachment.	(Bakker et al., 2014; Charter and Keiller, 2014; Liu et al., 2009; Mont, 2008)
Disposition		
Reuse	Decisions to extend a product's life through secondary use are typically a result of perceived value of the product. The perceived value leading to secondary use can be for the individual or value to sell/give to others.	(Liu et al., 2009; Ongondo et al., 2013; Yuan et al., 2008; Zhang et al., 2011)
Return	Essential to reuse, remanufacturing and recycling is an ability to reclaim the product at the end of life. Convenience is one of the key drivers for returning products. Convenience is governed by situational factors such as proximity as well as psychological factors such as perceived value.	(Bakker et al., 2014; Che and Hui, 2010; Geng et al., 2013; Greyson, 2007; Liu et al., 2009; Manomaivibool and Hong, 2014; Ueno, 2001; Zhijun and Nailing, 2007)

Purchasing

In many cases, implementing CE principles will cause an increase in cost for offerings due to changing materials, processes, supply chains, or business practices. Through a survey-based study, Liu and Bai (2014) showed that uncertainty about the marketplace and customer willingness to pay is a major barrier for firms' adoption of CE principles. Understandably, several studies have tried to find demographics willing to pay for environmentally friendly products (e.g., Chinnici et al., 2002; Mainieri et al., 1997; Vlosky et al., 1999). These findings do show that such demographics exist though the extent to which findings can be extrapolated to other contexts is not clear. Demographic factors influencing willingness to pay include: interest in domestic or local production (Hustvedt and Bernard, 2008), geographic location (Moon et al., 2002), and income (Chinnici et al., 2002).

Changes in offerings and modes of consumptions will likely change satisfaction and trust in a brand. Customer satisfaction and subsequent brand trust is the result of consistent, long-term company behaviour (Delgado-Ballester and Munuera-Aleman, 2001). Given that the circular economy is still young, it may take time for companies to establish trust with new offerings. Many consumers, for instance, seem to be wary that products labelled as 'green' are actually 'green' (e.g., Liu et al., 2009). This appears to be the result of increasing company emphasis on sustainability practices without regulation of sustainable claims.

Cascading resources within the circular economy requires that consumers buy offerings with the most possible secondary resources and minimum raw materials (Yuan et al., 2008). The generally negative stigma against used goods presents a significant obstacle for the circular economy. This stigma is a major barrier in remanufactured (Zhang et al., 2011) and reused products (Ongondo et al., 2013) including products that are reused through sharing schemes (Bardhi and Eckhardt, 2012). The stigma against second-hand goods is often referred to as contamination and has been explored to some extent in the literature (Angyal, 1941; Argo et al., 2006; Baxter et al., 2016a; Morales and Fitzsimons, 2007; O'Reilly et al., 1984). Overcoming this aversion to used goods is an important task in realising the deployment of the circular economy (Hood, 2016).

Engaging in (new) business models

The goal of reclaiming material to encourage recirculation may shift the focus from traditional purchasing in many cases towards renting and sharing. These types of situations, in which many users engage with the same product, can help achieve resource reduction through better resource utilisation (Cooper, 2005; Mont, 2008). These forms of acquisition theoretically benefit from increased resource efficiency, decreased material flow, and an appealing business scenario in which the company charges per use rather than per unit sold. Such a model is regarded as a needed change for the circular economy (e.g., Yabar et al., 2009). Though most consumers will have engaged in these types of models before, the extent of engagement in new contexts requires new learning for most users.

Early work has made sense of some key differences in non-purchasing acquisition. Belk (2010) describes the dimensions of sharing and shows that shared goods have a mutual sense of ownership and that sharing is often based on altruistic motivation. This type of behaviour often occurs within close groups of people (i.e., family and friends). Bardhi and Eckhardt (2012) show that sharing differs from access-based consumption (such as leasing and renting) in that access-based consumption is not altruistic but rather utilitarian and opportunistic. They offer six dimensions for the field of access: 1) temporality, 2) anonymity, 3) market mediation, 4) consumer involvement, 5) type of accessed object and 6) political consumerism. Chen (2009) challenges the idea that possession is the ultimate expression of consumer desire and shows that those accessing and possessing an object may fundamentally seek different types of relationships with the object.

Some modes of consumption may share benefits of traditional ownership, as seen in sharing, while others could significantly change the way consumers interact and engage with a product, as seen in access-based consumption. This change in ownership presents several obstacles as it changes cultural, psychological, and financial engagement with objects. Most fundamentally, it changes the relationship users have with an object and how this relationship is understood by others. Renters, for example, do not acquire investment, pride of ownership, depreciation credits, or the sense of security typically associated with ownership. Renters also suffer from negative cultural perception such as having less financial power and status (Durgee and Colarelli O'Connor, 1995). Compare this to the relationship individuals create

through legal ownership which provides owners the right to regulate or deny access to others; to use, sell, and retain any profits yielded from the object's use; and to transform its structure (Snare, 1972). Snare also notes that ownership has historically been seen as cheaper, a means to capital accumulation, and a way to provide a sense of personal independence and security. Consumers are able to develop a range of relationships with products (Ortíz Nicolás et al., 2013; Shimp and Madden, 1988) to the point that products help define (Belk, 1988a) or transform (Schouten, 1991) their identity. Contrary to notions that the desire to own is changing among Millennials, it appears it is still a top desire for many of these very reasons (Rosen, 2016). It is no surprise then that the desire to own remains a major obstacle in transitioning towards service models (Tukker, 2013). Therefore, the ownership hurdle under service schemes does not only fight against social constructs of independence and security but also fights against the development of an individual's identity.

It is possible for people to develop feelings of ownership for things they do not legally own. This “psychological ownership” can provide an interesting relationship through which identity, comfort and many of the other desires sought in legal ownership can be achieved (Pierce et al., 2003). Moeller and Wittkowski (2010) show that demand for services in which there is no ownership from the consumer is negatively influenced by “possession importance” (the importance that a consumer attaches to full ownership) and positively influenced by “trend orientation” and “convenience orientation”. There are several other potential determinants such as experience orientation, price consciousness, and environmentalism that do not appear to influence preference for non-ownership modes of consumption. Contamination, as described earlier, is an obstacle to ownership and individuals often cleanse a product of any trace of the previous user before they can take possession of it themselves (McCracken, 1986). In access models, contamination is one reason that individuals have failed to connect with the product (Bardhi and Eckhardt, 2012).

The concern over non-ownership was highlighted by Liu et al. (2009). Their survey results showed that 72.7% of respondents would not rent a toy or camera for children. This appeared to partially be attributed to economic status—if they had the money, they would just buy it—but it also dealt with contamination as some respondents noted that they did not think the toys could meet their standard of health. Liu et al.'s work demonstrates the need for

additional research in two areas. First, more foundational research is needed to understand the drivers behind ownership. Second, shared use in areas of China may differ from that in the western world. An analysis of the similarities and differences could provide another needed area of research.

Critical behaviours in product usage

The use stage of possession impacts the biological and technical material flows of the circular economy. Biological flow is impacted by user-regulation of resources associated with a product (e.g., fuel, energy, water, emissions, etc.). The concern here is primarily about the quantity consumed and any consequences of consumption such as the discharge of pollutants. Technical material flows are determined by how long a product is kept in use and what condition the product is in at the end of its life. This section investigates these material flows in the context of two behaviour categories: resource consumption and a willingness to care for the product.

Resource Consumption

Resource consumption includes all behaviours in which electricity, fuel, water, materials or other resources are expended during use. Within the circular economy, resource consumption can be framed in the context of material flows. Resources could be categorised as biological materials that can re-enter the biosphere, technical materials that cannot safely re-enter the biosphere or some hybrid combination of the two (EMF, 2013a). Though the idea of reducing resource consumption is not new to the circular economy, it has been reframed. In a circular model, resource consumption itself is not bad so long as the material circulated can be returned to the system with the same value. Unfortunately, much of recycling is, in actuality, downcycling because of lost value of the material (McDonough and Braungart, 2010). A version of downcycling may also occur when the perception of the material diminishes and is only seen as suitable for secondary markets (Baxter et al., 2017a). The circular economy is then concerned with the extent to which materials are used and removed from or downcycled within the system.

Consumers impact resource consumption on several fronts. The use stage generally accounts for the largest environmental impact of durable goods (Wever et al., 2008). Until energy comes from a renewable source, this is counter to the circular economy given that the

material used to generate energy cannot be reused. There are also a number of externalities that arise from consumption. For instance, environmental pollutants, such as CO₂ emissions are driven by urbanization and increased household expenditure in China (Peters et al., 2007; Zhou et al., 2012) and similar unsustainable resource consumption is well documented across the globe (Foley et al., 2005; Jackson and Papathanasopoulou, 2008; Vitousek et al., 1986, 1997). This contributes to the same issue originally posed by Pearce and Turner with the circular economy (Pearce and Turner, 1990). Namely, that the environment is being used as a waste reservoir rather than including designed interventions to reclaim resources. Many consumer behaviours contributing to this 'unsustainable' consumption (e.g., energy or material usage) are habitual and are very difficult to change without the implementation of new tools (Aarts et al., 1998; Maréchal, 2010). To break habitual behaviour patterns, products or services can be made to be more usable and target people who are already experiencing major changes in their lives (e.g. moving to a new location) (Verplanken and Wood, 2006).

Concerns over resource consumption is further related to the throughput of technical nutrients in the form of products, components and materials. Tim Cooper has noted that improvements in efficiency are not enough by themselves and that sufficiency also must be considered (Cooper, 2005, 2010a). This is particularly true if the use of products speeds the process of devaluation. Energy use, pollutant generation, and throughput of material are all important factors considered in resource consumption.

Product care

How a product is treated during use can influence its ability to later circulate within the system. This is most evident with using product maintenance to extend the life of the product. This may be thought of as a very small circle of use in which the product is used and maintained at times it may otherwise be made obsolete. The cost of maintaining an object often increases over time and is problematic with cheap alternatives on the marketplace. While some work does investigate product life cycle optimisation and countering planned obsolescence (Burns, 2010; Evans and Cooper, 2003a, 2003b) it seems there is relatively little research on the consumer's influence on extending the product's life (Antonides, 1989; Cooper, 2005; Mont, 2008). One notable idea argued by Jonathan Chapman is the need for 'emotionally durable design' which contends that durable products are only good so long as

a consumer does not get tired of them and discards them (Chapman, 2010). The idea that emotional relationship to a product has been supported empirically. In a set of studies, Belk (Belk, 1987, 1988b), showed that the more strongly homeowners emotionally attached to their dwellings, the more frequently or recently they reported taking care of it (mowing the grass, remodelling, painting, dusting). These studies also revealed some stronger emotional ties were seen when the dwelling was built and acquired more recently and was in better condition.

Product care also has important implications for reuse and remanufacturing as the quality of the product may help determine its usability at the end of life. In general, when a product is recirculated, steady performance levels need to be maintained and allowed to only hardly drop throughout the lifespan of the offering (Tietze and Hansen, 2013). Ongondo et al., (2013) showed how this can be problematic in the reuse of ICT parts since many parts had been stripped of vital components and it was difficult to find enough quality products.

In the case of shared goods this is even more problematic since people treat objects differently than if owned (Cooper, 2010b). This has been routinely established through endowment effect² studies that show that products included in a consumer's possession will be more highly valued (Kahneman et al., 1990; Kahneman and Knetsch, 1991; Thaler, 1980) and the higher the sense of ownership, the higher the given appraisal of an object's value will be (Reb and Connolly, 2007). Conversely, if a product is now owned it may be used less carefully resulting in higher stresses causing potentially more damage to the product (Feeny et al., 1990; Hardin, 1968). When damage or other evidence signals use by another person in a shared use context it contributes to the contamination discussed earlier. In car sharing, smells, such as those from cigarette smoke, provided such a contamination effect (Bardhi and Eckhardt, 2012).

The extent to which an individual cares for a product impacts durability during the usage stage and the ability to utilize the material post-use. Repair allows consumers to extend a product's

² The endowment effect is a hypothesis stating that people give more value to things just because they own them (Roedeliein, 2006).

life. Like factors influencing care, repair is highly driven by cost, ease, modernity, and product attachment.

Critical behaviours in product disposal

The circular economy depends on an ability to reclaim and recirculate products in the system. This requires a foundational understanding of disposal behaviour and contributing factors. Multiple taxonomies have been developed for potential end-of-life behaviour (Jacoby et al., 1977; Young and Wallendorf, 1989) though, in the circular economy, the focus is on those behaviours surrounding repair, reuse, remanufacture, and recycling of consumer goods. Disposal is often governed by the lowest cost to the consumer. Costs can be related to financial obligations, mental effort, or required time. Such costs may be weighed by the consumer. For instance, even those that take the time to sort recycling may weigh the cost of the spent time against the alternative of contributing to additional waste.

Reuse

The first option for circulation at the point of disposal is that of reuse. Reuse is “any operation by which products or components that are not waste are used again for the same purpose for which they were conceived” (European Union 2008). This thesis examines reuse more broadly to include instances in which a product or component is used again for a further purpose beyond what was originally intended. Inspired by Lucas (2002), Shipton and Fisher (2010) developed a framework which indicates when and where packaging items are evaluated for potential further use within the home setting. While this framework was specifically developed for the reuse of packaging, the same principle holds true for other types of products. Specifically, products are evaluated as to where they may be useful elsewhere. Careful design of products may enable further use of products in the home setting. It may be difficult to track this type of behaviour since it remains with the user and does not re-enter the system. Consequently, it likely happens more frequently than thought.

Return

If a product is not reused by the user, it needs to be returned to the system somehow. As was the case with reuse, decisions to return a product to the system for secondary use is typically a result of perceived value of the product. Whereas reuse is driven by perceived value to the individual, returning a product occurs when there is perceived threat to not return the

product or an incentive through perceived value to others. This process is highlighted by Mont (2008) who explains that when old products are not disposed of they are often downgraded in use or enter second-hand markets. Survey results from Liu et al. (2009) indicate that most respondents classified garbage into categories that could be sold, reused, or exchanged for new ones though many viewed this as inconvenient. This process of sorting creates a fundamental change in the user-object relationship as it transitions from a possession to a resource (Denegri-Knott and Molesworth, 2009).

While the return of products is increasingly made simple in peer to peer markets such as those facilitated through online platforms, it can be much more difficult for companies (Bakker et al., 2014). In part, this is because there are a number of logistical issues surrounding the effective circulation of many products. Many times it is difficult to obtain a useful quantity of goods (Zhang et al., 2011). In other situations, needed information about the products is often lost during use which can make it more difficult to reclaim value in the product (Thomas et al., 1999). Finally, the logistics of returning an object to the system is often more difficult for the user creating greater need to establish better user experiences in the use phase. This is most notably documented perhaps in work on the cost to the consumer. For instance, making a connection between demographics and sustainable behaviour has proven difficult (Evans and Cooper, 2003b, 2003a; Strandbakken, 1997; Tippett et al., 1978; Vining and Ebreo, 1990). Other factors have emerged as more important, however, such as financial considerations, negatively framed message conveyed by a personal acquaintance (Lord, 1994), or convenience (Chen and Tung, 2010; Domina and Koch, 2002; Ewing, 2001; Vining and Ebreo, 1990). Wagner (2013) categorized convenience into the following: knowledge requirements, proximity to a collection site, opportunity to drop-off materials, the draw of the collection site, and the ease of the process. This may be elaborated by a series of studies led by Trudel and Argo show the subconscious sorting decisions made about recycling (Trudel et al., 2016b; Trudel and Argo, 2013). In essence, this too notes how the cost of mental effort (i.e. conscious thought) is often needed to increase recycling rates.

Essential to reuse, remanufacturing and recycling is an ability to reclaim the product at the end of life. Convenience is one of the key drivers for returning products. Convenience is governed by situational factors such as proximity as well as psychological factors such as

perceived value. Return is primarily about keeping the product in the larger system external to the individual.

2.3. Discussion

The overall question addressed by this chapter is: how do user-object interactions—a relationship framed as possession—change in the circular economy? The follow-up question to this is how can design be used to provide more meaningful interactions with such possessions? The review in this chapter focused on six critical behaviours. In so doing, the first question was broadly addressed. Importantly, this chapter also provides a springboard from which additional inquiries can be made regarding the second question.

This chapter positions the user as a key participant in the circulation of material flows. The user inherently adopts three roles in this process: acquisition, usage, and disposal. More interesting are perhaps the roles played by a user which transcend these behavioural activities. For instance, users act as evaluators or appraisers in each part of the process. In this light, we can return to the discussion at the beginning of the chapter in which users are viewed at times as active participants who consciously make decisions and other times as passively responding to the stimuli placed before them. While the “right” way for users to engage in the circular economy relies on contextual factors, this adds a layer of understanding in which both passive and active evaluations may take place when decision making occurs.

From this work, two key trends emerge. Perhaps unsurprisingly given the scope of the review, the first theme is a recurring interest in ownership. Clearly ownership is an issue when moving away from purchasing towards access models. A stronger understanding of ownership would improve business models and provide better user experience. Ownership also plays a significant role in product care and product longevity decisions by users. This is supported by the link that has been established between the endowment effect, object attachment, and outcomes such as stewardship and loss aversion. Finally, in contrast to the vast knowledge around how and why people take ownership (i.e. purchase) of an item in a traditional setting, very little is known about why they engage in access models and how and why they dispossess of an object.

The second theme that emerged is the importance of the changing meaning as objects move between users and as they age in their own use process. This value change with movement between users and uses emphasizes an important element of design that is often assumed by analysts and discounted by practitioners. This provides an incomplete picture of the circular economy and casts the user aside as an afterthought rather than a central consideration of the design process. An alternative human-centred approach requires experientially transferrable user experience as noted in Chapter 1. In these situations, there is some interest in how the relationship with an object appreciates in value over time, for instance, in designing products to which users get attached. Though perhaps idealistic, all interactions should be considered in terms of how they can be made more positive for users. Take, for instance, the example of electric waste that is stripped of vital elements when returned which makes them unusable (Ongondo et al., 2013). At first glance, this situation seems like it could be solved with a relatively simple intervention: make it impossible to remove the vital elements of the electronic waste. However, the user experience may not be predictable in such a situation. Limiting what the user can do with the product shifts the value that is perceived by the user. If, for instance, these vital elements are resold, users may sell the entire unit or opt to go with a different offering which can be stripped and resold. Both scenarios would continue the issue of not being able to adequately reclaim the material. In such a situation, it may be appropriate to offer compensation for returning the product in good condition. The human-centred response should always keep an eye on where value is kept for the user and how this can guide interactions.

Overview of the empirical studies

The remainder of the thesis reports on empirical studies before discussing general conclusions. The studies are centred on the two themes previously discussed. The deeper investigation of ownership begins with Study 1 which explores what it means to own and presents a framework which describes the process of owning. This provides insight as to how meaning is gained from the process of possession and how this can be influenced through design. The immediate application for this is in better designing access-based consumption models. Study 2 builds on the first study by linking the theoretical backing of the developed framework to object attachment. This possession-centric view of attachment consolidates

prior work in the area and provides a set of affordance principles from which designers can work. Study 3 extends the work on attachment to show how it relates to decisions around product longevity. Studies 7 and 8 provide a more detailed investigation of lifetime considerations of circular possessions through understanding some factors influencing proper disposal.

The changing value of products leads to what I have termed contaminated interaction. This is the idea that the interaction with an object is influenced by some prior use. Examples of the importance of this arise in Studies 2 and 3. Study 4 positions contaminated interaction as a third type of contamination influencing circular material flows and explores the way in which it acts as a barrier to the circular economy through an investigation of case studies. Study 5 expands this understanding by offering a foundational study on what indicates use and what causes feelings of contamination. These findings are further substantiated and coalesced into an ontology in Study 6. This includes an investigation of the types of contamination and the operation of positive and negative contamination. Finally, in addition to demonstrating proper disposal, Studies 7 and 8 act as case studies of how contaminated interaction influences behaviours critical to the circular economy.

2.4. Conclusion

This chapter identifies those behaviours that are critical to the circulation of material flows and positions individual consumers as key actors in the circular economy. A review of literature showed six behaviours that should be considered for circulation across the acquisition, use, and disposal of a product. This approach is unique from others in that it does not dictate whether individuals should be active or passive participants in their knowledge of the circular economy but instead focuses on what they must do. Where some talk about the transition from consumer to user in the circular economy, this also highlights how that does not provide a clear picture of what is being done. Instead, individuals will at times own or not own products, consume or not consume resources, and knowingly or naively engage in the circular economy but will always act as circulators whose contribution to material flows should not be trivialized.

3. Possession as a meaning making process

In 2015, *Fast Company* featured an article called *The “Sharing Economy” is Dead, and We Killed It* (Kessler, 2015). The article documents the rise of entrepreneurial interest in the sharing economy born from the idea that we can better utilise products that lie dormant for most of their lives. It makes sense, doesn't it? After all, how often do we use our cars, power tools, toys and other goods? Why not lend those out to someone else that could utilise otherwise stagnant resources and in the process, make a small profit? This is exactly the thinking of many startups which aimed to capitalise on the idea. Unfortunately, essentially all these ventures failed. As one entrepreneur put it, “everything made sense except that nobody gives a shit. They go buy [a drill]. Or they just bang a screwdriver through the wall” (ibid). The comment pays tribute to the long held mantra repeated by proponents of the sharing economy that “People want a hole, not a drill” (Botsman and Rogers, 2010). In other words, provide the result people are looking for, not the means—people may not necessarily want (to own) a drill but they want the hole it produces. So, what was the problem? It seems we haven't yet figured out the hole.

Understanding why and how people possess things is at the heart of the circular economy given the extent to which circular processes change or redefine this user-object relationship. In some cases, individuals are asked to maintain their possessions to increase product longevity. New business models look to replace traditional ownership with access schemes. Use and disposal are increasingly examined, monitored and regulated to ensure proper circulation. In these cases, a better understanding of human drive to own is needed. Such a

human-centred approach will focus on the motives and desires of the user (i.e. the “hole”) rather than the business models that offer opportunity. This chapter presents a theoretical framework for the process of possessing an object³. The framework builds on psychological ownership theory (Pierce et al., 2003) and is contextually grounded through a study of individuals’ traditional, accessed and digital possessions.

3.1. Returning a focus on possession

Taking possession of something has long been seen as an innate human desire (Belk, 1982; James, 1890). This desire leads to actions which create feelings of possession. Feelings may exist for things legally owned (e.g. *my book*), temporarily accessed (e.g. *my seat on the bus*), or abstract in nature (e.g. *my idea*). Understanding such feelings of possession is prerequisite to making sense of many daily interactions. For instance, without understanding what it means to possess, the concepts of selling, gifting, buying, borrowing and stealing would be meaningless (Snare, 1972). This highlights the implicit role possession plays in society. As society evolves, so do the laws, policies and norms that quite literally govern how we interact with the objects around us (Linklater, 2013). It is then no wonder that small changes in how things are owned tends to be imperceptible. The trend, however, has been that laws increasingly become dematerialised personal rights that mediate interpersonal interactions rather than define our relationships with things (Graham, 2011). Thus, in this context, possession is taken as a mental state that is followed, not preceded, by policy. Particularly with the ambition to redesign the global economy, changes in ownership are more dramatic and require closer scrutiny to create meaningful interactions and positive user experiences. This will involve a return to focus on what it means to possess.

Two clear areas where possessions need to be rethought involve advancing technology and shifting business models. Digital possession and access-based consumption are investigated to identify a framework for understanding possession and contextual knowledge around the process. While the notion of access-based consumption may seem closely linked to the

³ Portions of this chapter have been published previously in a conference proceeding and are reused here under the personal use clause of the copyright agreement (Baxter et al., 2016c, 2016a).

circular economy, digital possessions are also informative. For instance, many traditional consumption modes have been upended by the digital revolution (e.g. music consumption). This adds a new element to what is owned and what can be developed further. The next sections explore ownership and possession for digital and access-based objects before presenting a study through which an ownership framework was developed.

Digital Possessions

Digitalisation of the world has dramatically changed the way in which we view and take possession of objects. In some cases, personal possessions have transitioned from material to digital as seen with photos. The way users acquire, maintain, curate, and dispose of the digital world varies significantly from how they might do it in the physical world and has been the focus of previous work (Odom et al., 2012). Understanding these interactions becomes paramount to creating meaningful transitions towards digitally owned things. In other instances, digital possessions have uniquely been created without a material transition as is the case with a domain name, website, or user account in a software program. The problem here is not in determining how interactions change but answering more fundamental questions. Why and how do users feel possession for some objects and not others? What do users want from digital possessions? Within the circular context, this is increasingly important as digital services become a more prominent way of managing material flows at all levels and the data captured in the process.

Understanding digital possessions is further complicated by the myriad of shifting policies surrounding the digital realm. Ownership in the material world has evolved over centuries of creating, amending, and disputing formal policies and legal terms. In the digital world, the discussion has barely been going for a few decades and is rapidly changing. Furthermore, in the context of shared ownership, the sharing practices that are well established with physical objects do not seem to function well when it comes the sharing of digital content (Gruning and Lindley, 2016). This may have happened because of the uncertainty and even anxiety arising from the ownership of digital possessions, especially when things are stored in the cloud (Gruning and Lindley, 2016; Marshall and Tang, 2012; Odom et al., 2012, 2013).

Policies around ownership, privacy, and consent within the digital space consistently make headlines and are disputed in courts. This will likely continue as we try to make sense of how

to properly interact with these spaceless, formless, and placeless objects. Digital user-object interactions are often facilitated and/or hindered by a company adding another layer of complexity to understanding how to construct this hybrid ownership particularly when accessed via multiple services or devices. Using the same service (e.g. cloud service) but at the same time having individual repositories makes the understanding of ownership more complicated than that of physical possessions (Vaida et al., 2013). This is also true for the collection of data. Digital and physical offerings increasingly collect user data. Determining who owns this data and what relationship should exist is a key part of enhancing this interaction.

Access-based models

Recently there has been increasing interest in developing business models where consumers gain access to products rather than owning them (Belk, 2010; Lamberton and Rose, 2012; Rifkin, 2000). As such research has begun characterizing access. Belk (2010) differentiates access from sharing. In his assessment, sharing is an often altruistic and love and care driven concept to create a community in which ownership and responsibilities of the object are shared amongst users. Conversely, access is not necessarily altruistic nor is it used to create a community. Bardhi and Eckhardt (2012) offer six dimensions of access that help define the changing context around access-based consumption: 1) temporality, 2) anonymity, 3) market mediation, 4) consumer involvement, 5) type of accessed object, and 6) political consumerism.

Much of the dialogue around access models seems to focus on the idea that people want a result, not the means to get it. This is exemplified in the quote credited to Theodore Levitt “people don’t want to buy a quarter-inch drill, they want a quarter-inch hole” (Christensen et al., 2006). Though this is sometimes the case, it often oversimplifies what users want. Perhaps the strongest evidence of this is the continued difficulty around getting consumers to adopt access-based models over traditional ownership (Tukker, 2013). In the instances where such models have been successful, the emphasis is placed on access and there is little or no sharing involved (Eckhardt and Bardhi, 2015). This is not to say that people do not (or cannot) develop a sense of ownership over the accessed object.

An example of some issues in designed access-based models are found in car sharing schemes. Bardhi and Eckhardt (2012) found that car sharing users do not identify with the car, feel it is not theirs and subsequently have no stewardship and at times report a feeling of disgust that someone else used the car. Despite this, it is important to note that even if an object is used for a short time, individuals may refer to it as *theirs*. This suggests that a more nuanced view of ownership may offer meaningful implications for what it truly means and what it might mean in an access model. Understanding this nuanced view of the feelings of ownership can help address many of the CE behaviours identified in Chapter 2 such as adopting new business models and understanding product care.

3.2. Study 1: Possession as a meaning making process

Methods

To understand the process through which people take possession of objects, a study was designed to collect the perspectives of participants and analyse them using principles from psychological ownership. The overarching idea here was to seek to contextualise psychological ownership theory in more traditional design thinking. For instance, understanding the interactions of various elements of the system and how design activities may relate to each. This study combines existing knowledge of how meaning emerges into a design process to encourage desired interactions and avoid undesired ones. The overall output is a theoretically based and contextually informed framework for a human-centred design of possessions. Importantly, this work explores the feeling of possession which is related but distinct from possessions as they enter and exit one's control.

Data collection

To better understand how possession relates to a wider system, semi-structured interviews were conducted with 13 participants. The interviews allowed us to collect first-hand accounts of interactions with and attitudes towards possessions. The strength of this approach is that it allows us to contrast a wide range of possessions in various contexts which inform the development of the ownership framework. The iterative approach of comparing emergent themes through varied contexts helps to better inform possession as a more holistic design construct. Though all interviews were conducted in South East England, the research benefits from a culturally diverse group of participants who come from 6 countries roughly equally

spaced across the Americas, Europe, and Asia. Among others, participant occupations included homemaker, photographer, engineer, management, student, and designer. A limitation of this research is that the average age of participants was fairly young (28 years old) and does not adequately reflect other age demographics.

Each interview included a series of questions around three categories of possessions: traditional material (i.e. owned) possessions, accessed (i.e. non-owned) possessions, and digital possessions. In this study, access was taken as anything material and not owned and no distinction was made between shared and accessed objects. All interviews were documented with audio recordings and notes. The audio recording was transcribed and coded into themes. The structure of questions first asked participants to think of things they felt they owned sequentially in the mentioned categories. Next, attention was given to a series of contextual considerations such as any organisations that may be involved. Themes included the motives and routes found in psychological ownership theory to conduct a cross-comparison of the data. Other themes were identified through an iterative process in which the authors met and compared analysis of the interviews to explore broader contextual issues such as the role played by entities essential to the interaction and external to the interaction.

Data analysis

Psychological ownership theory is the lens through which user-object relationships are explored. Psychological ownership is the mental state in which individuals feel that an object is theirs (Pierce et al., 2003). The theory describes the motives and routes leading to feelings of ownership for an object. Under the theory, the target of ownership can be any range of things including tasks, ideas, organizations, products, and digital spaces (Avey et al., 2009; Baer and Brown, 2012; Baxter et al., 2015a; Kim et al., 2016; Shu and Peck, 2011; Van Dyne and Pierce, 2004).

Psychological ownership posits that users have three motives for taking possession of an object and that this is achieved through three routes (Pierce et al., 2001, 2003). The three motives are: efficacy and effectance, self-identity, and having a place to dwell. Efficacy and effectance refers to the desire to feel competent through the ability to control and impact one's surroundings. Self-identity refers to the desire to create, continue, and/or transform one's public and/or private identity. Having a place to dwell refers to the desire to gain and

preserve physical, emotional, and mental security through familiar and comfortable surroundings.

These motives are achieved through three routes: control, intimate knowledge, and self-investment. Control is the ability to access, use, or transform an object when and how desired. Intimate knowledge comes as users acquire information about the object through use or other means. Self-investment is the expenditure of time, money, physical effort, and/or psychological energy into an object. A prerequisite to the routes is that the object attracts or engages the user.

3.3. A general framework for possession

Ownership is a state of mind that results from the interactions that users have with the target objects. This state of mind signals meaning for users. For example, there is some embodied meaning in users changing their wording from “the object that I use” to “my object.” In this latter case, the object becomes something that the user connects with, expresses expectations towards, and often defends. While interactions varied, this research confirmed that participants readily identified material, digital, and accessed objects for which they felt some sense of ownership. The aforementioned motives and routes were the guiding principles for seeking to own and taking possession of all object types investigated. The study provided new contextual understanding of how user-object relationships develop with all the constituent elements. The resulting process of ownership is represented through five elements: the user, the object, the interaction between them, and core and auxiliary entities. The user-object interaction is enabled by core entities (e.g. producers, sellers, services), supplemented by auxiliary entities (e.g. family, friends, third-party service providers), and fulfilled by the aforementioned routes. A framework to depict this process is shown in Figure 3-1. Each of the elements of the ownership framework are discussed below and contrasted across possession types.

User

The user on whom the process is centred is characterized by motives, capabilities and responses within the context of creating possession of an object. The motives were consistent with those previously discussed in psychological ownership theory across the three object categories. For any given object, regardless of the category, multiple motives were often

found suggesting that no one motive dominated an object category. Capabilities matched with product features afford interactions with objects. The responses that users have towards possessions are also an important consideration. Common responses include: higher valuation, stewardship, and altering how the object is used. Such responses can then shape future interactions. For example, stewardship can lead to more self-investment. Users are constantly changing through the possession process as they receive feedback from the interaction (e.g. how well objects fulfil the routes) and from core and auxiliary entities.

Object

The object (i.e. the target of ownership) is characterised by its product features. Features are the physical or digital aspects of the product which provide the user with perceived affordances. Features do not include prior knowledge or subjective attributes given to the object by the user. These are understood as either the user’s response to how well a feature meets a motive—including motives not leading to ownership—or as cultural appraisals, which are considered to be an auxiliary entity. In the case of material possessions, the object may

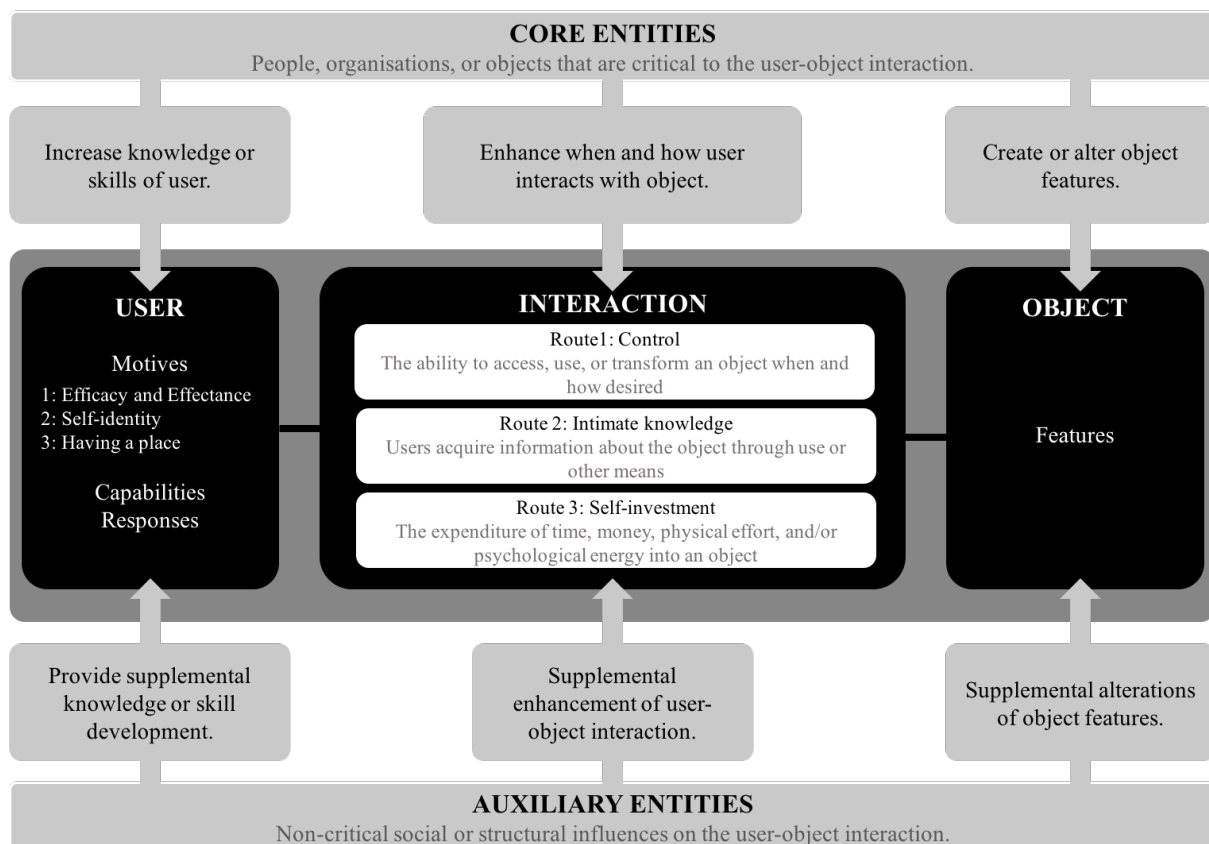


Figure 3-1. Human-centred possession framework.

change through situations such as maintenance. In accessed and digital possessions, change is frequent and marked by upgrades, refurbishment and other practices.

Interaction

The interaction between the user and the target object is of interest as it fulfils one of the three routes to ownership. All object categories investigated showed numerous examples of the routes being fulfilled demonstrating their usefulness across various possession conditions. Changes in the fulfilment of routes was due to differing product features, user capabilities or the supporting entities around them. Interactions are supported or hindered through the influence of core and auxiliary entities. Examples from the study suggest that this may be due to influencing how and when the object is used. For instance, P2 reported feeling ownership for a location, where she locked up her bike (access). When another person had taken the spot, she felt a lack of control over using the location when desired and found another spot that she could make *hers* and that she would have more control over. Finally, interactions are events that happen over time and should be considered across some specified period of use.

Core entities

Core entities are those people and organisations that are critical to the user-object interaction taking place in the first instance. At a minimum, this includes an individual since the features of the object were designed by a designer. In practice, there are often multiple core entities that produce, sell, facilitate, service or otherwise critically enable interaction with the object. Multiple users spoke of a mobile phone as a possession example. In this case, formal entities included companies behind the hardware, operating system, and mobile phone service. In some cases, the interaction with the features of a phone (e.g. messaging services) is dependent on another user having the same features. In this case, the other user and the feature developer would also be considered core entities. Other products can act as core entities when the fulfilment of a user's motive depends on it. P3 shows an example of this in talking about his video game which requires a game console to be used. In this sense, the core entities mediate the interaction between the user and the object. Core entities also moderate the interaction in that they can influence the fulfilment of routes in a positive or negative way. In the case of material possessions, the main role of the core entities ends at the point of sale

when the object and all the rights that go with it are turned over to the user. Access and digital contexts, however, are similar in that they often maintain an influence over the user, the object and the interaction throughout the use of the object.

Auxiliary entities

Auxiliary entities are characterised by their non-critical influence over the user, object, or interaction. The results suggested two types of auxiliary entities: social and structural. Social entities included family, friends, celebrities, or other sources for cultural frames. Structural entities provide types of supporting services such as maintenance shops, accessory producers, and special interest groups. While these are not critical, they do act as moderators in that they can enhance or hinder the fulfilment of the routes. These entities exhibit influence over the user, object, and interaction throughout use. This differs from core entities in that this influence is generally continuous for all types of possessions including material ones.

3.4. A contextual understanding of possession

The base case for this study is that of traditional possessions as they are the most familiar and often act as a starting point from which accessed possessions are created and digital possessions are conceptualised. Examples of traditional possessions explored in this study include: a purse, a money clip, a coat, lapel pins, a laptop and toys. Traditional possessions share the physical nature of interaction with accessed possessions but differ in the contextual construction of those interactions. Accessed possessions considered in this study included: a city bicycle, a family car, an apartment, a company desktop computer, and a company mobile phone. These often share a common contextual basis with digital possessions when neither are legally owned. At the same time, they differ in material nature. Examples of digital possessions considered in this study included: a web domain, a video game, social media accounts, spreadsheets, cloud-stored photos and mobile phone application accounts. Variations in context influences expectations and trust.

Expectations and trust

Traditional material possessions often transfer meaning to the users at the point of sale. While the feelings of possession and the meaning derived by the user change over time, the expectations from the product do not seem to change significantly. For a material possession, the expectations generally revolve around the object performing an expected task over an

expected time. This embodied expectation is somewhat unique to material possessions. For accessed and digital possessions the expectations are often not on the object, but on those core entities involved in enabling the interaction. P13 shared the experience of moving into a rented property for the first and the frustration in relying on the landlord to fix things. “We had a weird smell coming from the sink and we had to call someone else to get it fixed instead of being able to fix it on our own. [Later] one of the faucets was [...] leaking into the flat downstairs but no one came to tell us. They tracked down the landlord and told him, and he called to tell us that there was a leak [instead of] a more direct approach to come upstairs and [tell us].” P11 spoke of a digital messaging service she would use to communicate with her friends and family around the world. Her frustration was with bad user interface features and she expected the company to improve to enhance her interactions with time.

There was a sense of tension around feeling the core entities can be trusted. Trust implies that someone or something will perform in a way in the future. For material possessions, this is well established as trust was placed in the finished object. Users felt that their bag, clothes, toys or other objects had a lifespan and they expected to get value from within that lifespan. For accessed and digital possessions, trust was transferred to the company. P12 spoke of his hesitant trust in a cloud service to protect his photos. P4 spoke of a social media account used on the phone and highlights the expectations and trust placed in an organization. “I hope the company who owns the app does something to make it better [...] but I do not allow this company to do something illegal, like leaking out my personal information.”

As an object becomes a possession, users tend to report a greater sense of stewardship. P7 explained that he feels ownership for his father’s car when he uses it and invests in it. As a result, he also takes better care of it. “When I use my father’s car, I really think it’s mine and I clean the car, take care of the car. [...] I feel like the car is mine. It becomes part of my life.” P1 talked of feeling responsible to quickly repair material objects. Stewardship was particularly strong when another person was going to use the object later. P9 talked of the city bicycle used to commute each day to work. “I think I need to take care of it. I think it’s mine because I don’t want to destroy it. Because other people are gonna use it too.” A unique finding of this study is the seemingly reckless behaviour that users showed toward their objects in contrast to others. P1 spoke of an expensive bag that she uses for work. “Maybe I

do throw things into it a little more often than I would if it weren't mine—obviously, I would never put something in someone else's bag. But I think the way that I put things into it [...] wouldn't really damage it or anything. But I'm definitely more relaxed with my bag than [someone else's bag]." P7 spoke of the risks he takes in drinking near his laptop and precariously holding it. He would never use another laptop that he did not own in the same way. This reflects the risk users are willing to take with their own objects to better fulfil the motives of ownership and the caution they feel when the object will be used by another.

3.5. Discussion

This chapter describes possession from a theoretical perspective and provides a model to understand interactions in context. In so doing, it highlights the complexities of possession and the key roles played by each of the elements of the model. In many ways, digital and accessed possession have the potential of being far more advantageous to companies and consumers given their continued connection throughout use. The successful implementation of these types of possessions as well as others depend on the ability of an organisation to offer efficacy and effectance, self-identity, and a place to dwell from those objects with which they interact as well as a system that reinforces these, not necessarily legal ownership. In this context, the motives are central to this thinking and suggest that any successful models in which users have a positive experience should consider these implications.

The model presented in this chapter offers a holistic approach to understanding ownership for accessed and digital objects. These possessions challenge traditional understanding as different forms of ownership can co-exist leading to situations of hybrid ownership. The model adds structure to other investigations of possessions and a framework through which designers might understand and analyse user ownership within a given context. It focuses first on user motives and joins with that product features as well as the roles played by core and auxiliary entities in the fulfilment of three routes that lead to feelings of ownership. In hybrid ownership conditions this becomes particularly useful as it provides a more nuanced understanding of what a possession is, why users want to take possession of things, and how various elements participate in the process.

Perceived ownership and the value derived from an object are directly proportional to the criticality of the object in fulfilling one or more motives. Users reported a high degree of

perceived ownership for those objects that were critical to fulfil a motive. They had a low degree of perceived ownership for objects that were not critical either because the motive was poorly fulfilled or there were available alternatives. Successfully fulfilling these motives then becomes an important step in creating meaning for the user.

This study suggests at least four ways in which design might enhance user ownership. First, the way in which an object specifically fulfils the motives of ownership can be more effectively communicated. Second, user skills can be enhanced to better utilize the existing features and functions of the object. This may be achieved by the core entities or through a myriad of support communities found in auxiliary entities. Third, the interaction between the object and the user can be improved by providing less restrictions on how the object is used. Fourth, object features can be enhanced to provide added opportunities to create meaningful interactions. In situations in which ownership is being altered or avoided, the framework also proves useful. Designers benefit from understanding more precisely what the user wants from the object in terms of motives and how the motives might be fulfilled in some other way.

Implication for circular possessions

Within the context of the circular economy, much value can be derived from a detailed understanding and application of the theory of psychological ownership—the mental state in which individuals feel the target of ownership is ‘theirs’ (Pierce et al., 2001). The theory lends new understanding to two important strategies for slower consumption: increasing product longevity and establishing access-based consumption models (Cooper, 2005). Product longevity generally concerns enhancing the user-object relationship, while access-based consumption redefines it. Despite promising directions in these areas (e.g. Chapman, 2005, 2010; Evans & Cooper, 2010; Tietze & Hansen, 2013; Tukker, 2004; Van Nes, 2010), many gaps remain which limit more widespread adoption of both strategies (Mont, 2008; Tukker, 2013).

Psychological ownership addresses why and how individuals own objects. As discussed in the chapter, this ownership is a psychological representation of the individual’s relationship to the object and subsequently is bound by interactions rather than legalese. For example, an individual may legally own an object without ever taking possession of it (McCracken, 1986) or conversely, individuals may have feelings of ownership when no legal ownership exists

(Pierce et al., 1991; Van Dyne and Pierce, 2004). This nuanced approach to understanding human factors through the lens of ownership should help explain the consumer concerns that have curbed access-based consumption models where companies retain ownership and offer short-term access to consumers. In other words, designers can use this framework to understand the intangible reasons people currently prefer traditional ownership and can identify ways to realise that intangible value in new ways.

This chapter has adopted a broad examination about psychological ownership to inform why and how people take ownership of things. However, as stated above, psychological ownership is also useful in understanding object attachment that could contribute to product longevity. This is because psychological ownership can help inform the basis for decisions to keep or discard things. This follows work that has directly linked psychological ownership to attachment and shown how it subsequently contributes to loss aversion (Shu and Peck, 2011). The use of psychological ownership to describe object attachment and inform decisions to keep, care for and discard objects is the focus of the next chapter.

3.6. Conclusion

This chapter presented a theoretical foundation of the process of ownership and how design can influence it. This addresses an issue which has long been overlooked in the development of product service systems and sharing economy offerings. The framework presented adapts existing theory which is informed through qualitative investigations of various types of possessions. This differs from previous design approaches in breadth as it takes a holistic approach to understanding the underlying factors of ownership and the links between each constituent element involved. Using this framework, designers can better approach design problems where ownership is altered or seeking to be enhanced.

4. Keeping, Caring, and Discarding

If a product is to be a circular possession, it must be considered beyond the point of sale. Decisions regarding keeping a product in use through maintenance, caring for a product so it can be utilised in a second life, and discarding a product when it is no longer valuable are each important considerations to influence the circulation of material flows. Understanding these points requires a better understanding of the user-object interaction as it develops over time. This chapter builds on the framework presented in Chapter 3 to show how the changing relationship of possession contributes to interactions throughout the product lifespan through to disposal. Specifically, this chapter shows how the framework of psychological ownership is useful in describing attachment (Study 2) and decisions around keeping and discarding (Study 3)⁴. This complements and extends existing work on attachment and obsolescence and strengthens a theoretical base from which consumer behaviour can be investigated and influenced through design.

4.1. Object attachment as psychological ownership

If object attachment is defined as a perceived psychological closeness to an object (Baumeister et al., 2014), then psychological ownership represents an extreme form of this closeness—one in which the object may become part of an extended self (Belk, 1988a). Shu and Peck (2011) directly link psychological ownership to attachment and show how it contributes to loss aversion. Other studies support this link to loss aversion (Baer and Brown, 2012; Kahneman and Knetsch, 1991) and highlight additional outcomes of attachment such

⁴ Elements of this chapter have been previously published (Baxter et al., 2015b, 2015a) and are reused here under the personal use clauses of the copyright agreements.

as higher evaluation (Franke et al., 2010; Reb and Connolly, 2007) and feelings of stewardship (Hernandez, 2012). In a wider perspective, psychological ownership theory is useful in providing a coherent model for attachment (Baxter et al., 2015a), the elements of which are stressed in a number of design-oriented attachment studies (Desmet and Hekkert, 2007; Mugge et al., 2006, 2009, 2010).

Attachment is related to interaction design or experience design, which both aim to intentionally create user behaviours and experiences (Hassenzahl and Tractinsky, 2006; Shedroff, 2001). Similar to research on psychological ownership, design-oriented studies show great interest in affective response (Barnes and Lillford, 2009; Desmet and Hekkert, 2007; Krippendorff, 2005; Norman, 2007; Ortíz Nicolás et al., 2013; Schifferstein, 2009, 2010) and attachment (Franke et al., 2010; Mugge et al., 2006, 2009, 2010; Norton et al., 2011). Creating experiences, however, is difficult partly due to their complexity. This is particularly true when the experience is directed at a target object (Oatley and Johnson-Laird, 1987). It follows that experiences cannot be designed, only designed for through affordances (Pucillo and Cascini, 2014). Affordances are simply the possible interaction with and use of an object based on the properties of the object and capabilities of the user (Norman, 2013). Recently, affordance-based design has received significant attention among design researchers (Maier and Fadel, 2003, 2009; Pucillo and Cascini, 2014; Srivastava and Shu, 2013; Xenakis and Arnellos, 2013; You and Chen, 2007).

The premise of this chapter is that the construct of psychological ownership is useful in understanding why and how individuals develop attachment to objects and that this then informs decisions around keeping, caring for, and discarding products. Previous design studies on attachment (Jung et al., 2011; Mugge et al., 2009) have covered partial aspects of the construct of psychological ownership but much can be gained from merging this thought with the structure of psychological ownership. The construct of psychological ownership offers a more holistic approach to object attachment in design, and has, therefore, been chosen as the lens through which the research is conducted. The aim of this chapter is threefold: (1) introduce psychological ownership as a construct for designing experiences and interactions leading to object attachment; (2) identify affordance principles to facilitate these experiences and interactions; and (3) explore the usefulness of this theory in describing intentions to keep,

care for, and discard objects. The first two aims are accomplished by mapping motives and routes to experience design frameworks (Hassenzahl, 2005, 2010; Pucillo and Cascini, 2014) and identifying affordance principles through contextual inquiry with 16 users (Study 2). The final aim is accomplished through a qualitative assessment of reported interactions with objects (Study 3).

4.2. Study 2: A model of object attachment

Background

As described in Chapter 3, psychological ownership is defined as “that state in which individuals feel as though the target of ownership (material or immaterial in nature) or a piece of it is *theirs*” (Pierce et al., 2001). It occurs through the experience of fulfilling ownership ‘motives’ (why an individual *wants* to own) through ‘routes’ to ownership (what an individual *does* to own) (Pierce et al., 2003). Attributes of the ownership target determine its ability to fulfil motives of ownership and therefore mediate ownership feelings (Peck and Shu, 2009; Pierce et al., 2003; Shu and Peck, 2011). If the object lacks necessary attributes or, as McCracken (1986) explains, if individuals do not find meaning in the object’s symbolic attributes, no feelings of ownership emerge. This can be true even for legally owned objects where the owner never seems to take possession of it.

Developing feelings of ownership occurs through experiencing a product. As such, this section examines work on experience design and psychological ownership to inform the development of a framework for psychological ownership-based attachment. Design research has proposed various experience design frameworks (Hassenzahl, 2005, 2010; Pucillo and Cascini, 2014). In Hassenzahl’s model (2010), designing experiences is mediated by interactive objects and governed by goal-directed actions. There are three hierarchical goals in this model: be-goals, do-goals, and motor-goals. Be-goals (e.g. to be in control) motivate and reflect the needs or desires of the individual. These in turn lead to do-goals that are more concrete (e.g. control the car). Finally, motor-goals describe how the do-goals are achieved (e.g. moving the steering wheel). Pucillo and Cascini (2014), building on Hassenzahl’s goal-based model, have proposed a framework of user experience in interaction based on affordances. This model is adapted in the present study and instantiated in the context of psychological ownership. Be-goals are matched to the motives for psychological ownership: efficacy and effectance, self-identity,

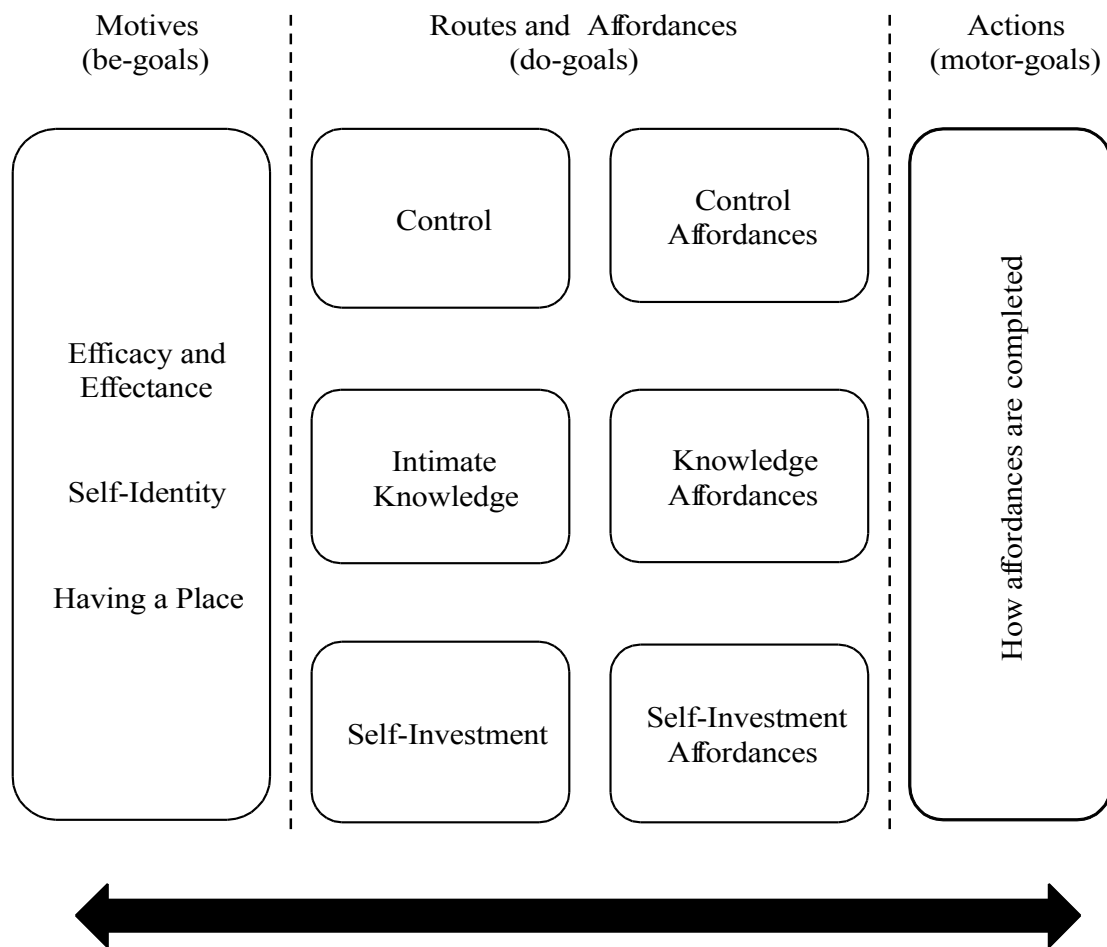


Figure 4-1 a psychological ownership-based framework for object attachment.

and having a place. Do-goals are mapped to the routes to psychological ownership: control, intimate knowledge, and self-investment. The routes are broad and leave room for more specific affordance principles to be identified within each route. Motor-goals refer to actions to complete the routes. This model is bidirectional in that motives encourage actions and actions, in turn, fulfil motives. The motives and routes for psychological ownership shown in Figure 4-1 are taken from the theory of psychological ownership by Pierce et al. (Pierce et al., 2001, 2003). These were introduced in the previous chapter but are explained in more detail here followed by a summary of affordances.

Motives for psychological ownership

Psychological ownership is driven by three main motives: efficacy and effectance, self-identity, and having a place (Pierce et al., 2001, 2003). These motives are analogous to be-

goals as shown in Figure 4-1. Understanding these motives is a foundation for developing successful user attachment.

Efficacy and effectance

Snare (1972) describes ownership as a special relationship in which the owner has the right to use, sell, transform, or extend (deny) access to others. The owner has ultimate control over the object. To be in control is one of the driving motives of possession (Isaacs, 1933). Being in control creates positive feelings of efficacy and it creates pleasure as desired outcomes are created. The desire to be able to control or alter an environment (efficacy) leads to feelings of competence or effectance.

Self-identity

Objects help create, continue, or transform our identities (Belk, 1987, 1988a; Kleine and Baker, 2004; Schouten, 1991; Tian and Belk, 2005). The objects we own communicate meaning to others and ourselves (Richins, 1994a, 1994b). Individuals seek out objects to create and communicate an identity to be (or appear to be) a desired person.

Having a place

An important human need is to have a place (Weil, 1952). Familiar objects often help people feel like they have a place or a home (Mehta and Belk, 1991) and those that are most effective are likely to be the possessions receiving significant emotional investment (Porteous, 1976). This familiarity, or place of their own, leads to a sense of security (Pierce et al., 2003). This encourages people to devote significant resources to take possession of target objects that can potentially become part of their home.

Routes to ownership

Do-goals illustrated in Figure 4-1 are analogous to the three routes to ownership: control, intimate knowledge, and self-investment (Pierce et al., 2001, 2003). Prerequisite to these routes is a degree of attractiveness of the ownership target that, as mentioned previously, mediates psychological ownership. If an individual is not attracted to the target they may not engage with any of these routes. When individuals are exposed to an object it generally becomes more preferable (Fang et al., 2007; Zajonc, 1968) though this does not always occur if the object is unpleasant (Meskin et al., 2013; Peck and Shu, 2009). Feelings of ownership also may be prevented or hindered due to contamination—disgust in response to an offensive

object (Angyal, 1941; Argo et al., 2006, 2008; Bardhi and Eckhardt, 2012; Hejmadi et al., 2004; Meigs, 1984; Nemeroff and Rozin, 1994; O'Reilly et al., 1984; Rozin et al., 1986, 1989, 1994; Rozin and Fallon, 1987). In such cases, individuals often need to strip an object of evidence of another person before taking possession of it (McCracken, 1986). Thus, contamination acts as a moderating variable in which case a user may feel like the object is someone else's until it is cleansed and the individual can take possession of it. Contamination is explored in more detail in Chapters 5 and 6.

Control

Control is both a characteristic of ownership (Snare, 1972) and a route to achieving it (Csikszentmihalyi and Halton, 1981; Sartre, 2012). In the context of everyday life, people frequently use small acts of control to make an object theirs (e.g., adjusting the height of a chair). The importance of control in developing ownership is partly demonstrated by the consequences of users losing control of objects. Several studies (Halme et al., 2006; Kahneman, 2011; Stø et al., 2008) highlight the lack of ownership and control over an object as a barrier to adopting less traditional modes of consumption.

Intimate knowledge

Feelings of ownership rise with information and familiarity about the object. Pierce and colleagues (2003) argue that feelings of ownership can begin to occur almost immediately. Evidence of this is the increased valuation or sense of ownership following even basic exposure to a stimulus (Peck and Shu, 2009; Zajonc, 1968). Exposure to a stimulus represents some gained knowledge (i.e., what it looks or feels like) though it takes time for the emotional aspect of ownership to strengthen (Strahilevitz and Loewenstein, 1998). Time allows an individual to get to know an object's basic features but also allows an individual to identify those features that differentiate the object from its nearly identical mass-produced counterparts. Jung et al. (Jung et al., 2011) identified this intimacy with an object over time as an important factor in developing love for objects.

Self-investment

Investing personal resources such as time, money, physical effort, and psychological energy into an object allows users to make the object (or part of it) theirs. In these conditions, "labor leads to love" (Norton et al., 2011) as the individual develops a special connection with the

object and the object even becomes part of the individual's extended self (Belk, 1988a). Self-investment strategies often fall under a myriad of activities related to mass-customization (Ferguson et al., 2014; Fogliatto et al., 2012; Mugge et al., 2009; Reeves et al., 2011).

Affordances

An individual's ability to claim something as theirs depends on how well the target of ownership allows an individual to control, intimately know, and self-invest (Pierce et al., 2003). In other words, feelings of ownership require affordances from the target object or the surrounding environment. Affordances are possible interactions with, and use of, an object given the properties of the object and capabilities of the user (Norman, 2013). A step, for example, affords step-ability to an adult, but not to a young toddler (Pucillo and Cascini, 2014). Originally, affordances were developed within psychology (Gibson, 1977) but have since been well-explored within design (Maier and Fadel, 2003, 2009; Xenakis and Arnellos, 2013; You and Chen, 2007).

Substantiating the model

This study aims to identify affordance principles aiding in the development of psychological ownership to help inform how object attachment can be facilitated. This is accomplished through a series of contextual observations that give insight on how and why people interact with objects. This approach is similar to that used by Srivastava and Shu (Srivastava and Shu, 2012, 2013) who identified affordance principles for environmentally conscious behaviour. In their studies, observing lead users provided insights to design patterns that were then abstracted to general affordance principles. Key to the value in their work and the present study is balancing abstraction and specificity, that is, principles should be abstract enough to be considered for a wide range of objects and at the same time be specific enough to provide meaningful design direction. Self-investment, for example, is certainly a design principle. It gives general directions of what the design should achieve in terms of behaviour but little direction as to how this is achieved. Polishing a pair of leather shoes is far too specific to be considered for a wide range of objects. A good principle under these conditions might be termed "maintenance," which is a sub-principle of self-investment and includes behaviours for many products including polishing shoes.

Method

In this study, affordance principles relevant to psychological ownership are identified through contextual inquiry. Contextual inquiry is a design research method comprising observations and interviews in the context of object use (Beyer and Holtzblatt, 1997, 1999; Holtzblatt et al., 2004; Martin et al., 2012). This has the potential of gaining insight beyond the consciousness of the observed user.

The studies were structured using the 'AEIOU' contextual inquiry framework which looks at activities, environments, interactions, objects, and users (Wasson, 2000) as well as semi-structured questions around the motives and routes to ownership. 'AEIOU' helps quickly identify observed elements and their interactions. This framework focuses on micro-level factors and as a result it does not guide in the identification of broader patterns. Accordingly, general questions regarding motives and routes were used to capture broader pattern-focused observations and thoughts (e.g. How does this object reflect you? What makes this object uniquely yours?). Four inquiries were carried out for each of the four selected object categories resulting in a total of 16 data points. Each data point represents an in-depth investigation of user-object relationships which by themselves could represent case studies. The data from these studies were transcribed and analysed through an iterative process to identify patterns (e.g. trends in behaviours that achieve one of the motives of ownership). Patterns were abstracted to general affordance principles that were subsequently classified according to their ability to help the user control, intimately know, or self-invest in the object.

Objects

Four objects—a car, a mobile phone, a pair of shoes, and a park bench—were chosen from which user-object relationships would be observed, assessed and analysed. The objects were chosen to show varying levels of complexity, size, value, and context. All the objects are generally familiar, making insight more easily described and understood.

After housing, the car is often the largest individual household expense. Cars are unique in that they form a self-contained environment that surrounds the user during operation. This environment is increasingly complex with significant amounts of technology. Cars also tend to serve significant functional (e.g. transportation) and symbolic (e.g. status) value for the

user. Cars were chosen to understand how a person takes ownership of large, expensive, complex, and meaningful objects.

Mobile phones are transforming technological and interpersonal interactions. They have an incredible global presence with 6.8 billion mobile phone subscriptions at the end of 2013 ("ICT Indicators Database," 2014). Phones are one of the few objects nearly always carried by users and while very similar on the outside, phones are greatly personalised through their software. This study includes smart-phones to investigate an object with personal sentiment and a strong software component.

Shoes differ from the first two objects in that they carry with them very little technology. They are among the most fundamental and functional possessions. More than the other objects, multiple pairs of shoes are owned and switched out depending on the circumstance or required interactions. Including shoes in this study provides insight into principles behind how low-tech items with ready functional alternatives become owned. The shoes worn by users at the time of the study were investigated and compared to other shoes in their possession providing insight into multiple objects.

Finally, the park bench is a radical alternative to the other objects. Like shoes, it has few, if any, technological features. In contrast to the other three objects, the bench is stationary and is not legally owned by the user. Despite no legal ownership, the bench still induces feelings of ownership (e.g. he is in *my* place). More than the other objects, having a place is the likely motive behind feelings of ownership for the bench.

Observations and interviews

Each object was observed with four participants for a total of 16 observations. Participants for the car, phone, and shoes were selected to provide a broad demographic range (age, gender, occupation, etc.) and all studies were done in the context of using the object. Studies for the first three objects lasted an average of 93 minutes. The park bench was studied in context (London's Hyde Park) but it differed from the others in that participants were approached at the location rather than selected beforehand. These participants used the bench for a minimum of 30 minutes. All participants were informed of the study and gave consent to be questioned, observed, and anonymously referenced in any publications. Table

4-1 provides a summary of the participants and their characteristics. Notes were taken during the observations following the ‘AEIOU’ and semi-structured question format previously discussed in this section and were later transcribed. Following the observations, an iterative process was used to analyse the data and identify patterns and principles.

Table 4-1 Participant characteristics for car (C), mobile phone (P), shoe (S), and park bench (B) observations

Name	Gender	Age	Occupation Category
C1	M	>65	Retired
C2	F	25-35	Mother
C3	M	25-35	Graduate Student
C4	M	45-55	Transportation
P1	M	25-35	Technology
P2	M	<18	Student
P3	F	25-35	Business Management
P4	M	>65	Real Estate
S1	M	25-35	Consulting
S2	M	35-45	Healthcare
S3	F	25-35	Business Management
S4	F	25-35	Graduate Student
B1	M	45-55	International Business
B2	Family	10-55	Unknown
B3	F	25-35	Public Relations
B4	Couple	>65	Retired

Results

The 16 data points were analysed to identify affordance principles for psychological ownership. As expected, there are significant differences between the nature and strength of the interaction between motives, routes, and affordances per object type. For example, a park bench is closely associated with the ‘having a place’ motive but has weak ties with the ‘self-identity’ and ‘efficacy and effectance’ motives. This contrasts with cars, phones, and shoes, which were more closely aligned to the ‘self-identity’ and ‘efficacy and effectance’ motives. This was not surprising since the latter three objects are often purchased for style, prestige or functional utility. However, it was surprising that these objects, initially intended to fulfil ‘self-identity’ or ‘efficacy and effectance’ motives, were found to fulfil the ‘having a place’ motive as well. For example, a car might be initially purchased for functional reasons (efficacy and effectance) and a specific car chosen for its aesthetic appeal (self-identity).

However, over time, the car might also become a place to think, relax, or escape (having a place). Interestingly, all the routes were present for all the objects. Overall, this provides a basis from which differing interactions are assessed to identify patterns and principles of attachment.

In total, 16 affordance principles were identified and categorised according to the route (control, intimate knowledge, and self-investment) that they afford (see

Table 4-2). All affordance categories were considered as widely as possible to reflect diverse interactions. Control affordances describe spatial and temporal control as well as the user's ability to change the object. Intimate knowledge affordances reflect ways to allow an object to communicate more accurately with the user. This communication occurs through object features as well as contextual factors. Self-investment affordances represent the range of user effort spent on interacting with an object.

The remainder of this section defines the affordance principles using examples. The list of affordance principles is not expected to be complete. Rather it is a step toward more intentional design decisions leading to psychological ownership and attachment.

Control

Spatial Control refers to the ability to manipulate objects through space. Shoe wearers reported adjusting how (S1) the shoes were laced or how tightly (S2). Phones were regularly angled when watching a video (P1, P3), taking a "selfie" (P2), or showing photos to others (P4). The car allowed all users to pursue their own driving style. When interacting with the bench, B4 moved their bodies into a diagonal position for comfort, while B3 moved along the bench to find a higher and flatter portion of the ground. There was a perceived sense of frustration when users were not able to manipulate the object as desired such as while taking a "selfie" (P3) or trying to parallel park (C2). Users make the object theirs by adapting the object to a more desirable position.

Configuration Control is the ability to arrange object settings. Cars have a remarkable amount of settings that can be changed by the user: lower seat position, seat back position, seat belt height, volume control, steering wheel height, rear-view mirror position, side-view mirror

position, audio selection (radio, CD, or other), window controls, vent directions, etc. Cars are particularly informative in creating one's own place, especially when shared. "Sometimes I get in the car and my husband has been driving [it]" recalled C2 and "the first thing I have to do is adjust the seat and mirror so it is comfortable again". In the phone's case, all users reflected to when it was new and noted that it did not become theirs until they had transferred their contacts, set their password, chose a background or ringtone, or configured other settings. These examples show how an ability to configure an object quickly makes that object a possession.

Table 4-2 Affordance principles to inform object attachment

Temporal Control is the ability to use the object when desired. The first three objects were praised because of convenience. “I love that I can get out of the city for the weekend with my car” (C4). “[My phone] lets me easily connect with friends all the time” (P2). “I grab my shoes and just go for a run” (S2). These cases all reflect temporal convenience—doing what they want when they want to. An interesting finding was that temporal control was also important for the park bench. B3 indicated that she specifically took time to come to a particular spot (and a particular bench). If people were already there, she felt that they had taken *her* bench.

Affordance Principle	Description
Control	
Spatial	Physically manipulate the object
Configuration	Arrange the object settings
Temporal	Use of the object when desired
Rate	Use as much of the object as desired
Transformation	Change the object as a result of interaction
Intimate Knowledge	
Ageing	Capture stories in object changes as it ages with the user
Disclosure	Convey origins and former experiences
Periodic signalling	Communicate on an event-dependent basis
Enabling	Mediate meaningful experiences
Simplification	Eliminate distractions
Proximity	Communicate through closeness
Self-Investment	
Creation	Bring something or part of something into existence
Repair and Maintenance	Service the object
Repository	Collect and store valuables within the object
Emblems	Signal information about identity
Preference recall	Remember previously established preferences

This principle of temporal control is distinct from delayed gratification, which typically reflects the user giving up an immediate reward for a later one. The act of giving up something is self-

investment and is reflected in the creation principle (e.g. my sacrifice has *created* this opportunity for me).

Rate Control reflects the ability to use the consumables of the object as desired. Two cases in particular highlighted the boundaries placed on the feelings of ownership. Smart phone users P1 and P3 both commented on the pay-as-you-go data plan that they had used. In these cases, the users prepay for how much data can be transferred to and from the phone. Towards the beginning of the month, the phone is used as desired but with several days remaining in the month allotted data from the service provider occasionally runs out and usage is restricted. As P3 explained, “it is just a reminder that the phone company actually controls how you use your phone.”

Transformation Control is the ability to alter the object during a given period of use. Through transformation, the object becomes something unique compared to when it was received. This differs from configuration control in that it does not just change the settings of the object but it alters fundamental aspects of the object. S4 recalled trying on second-hand shoes and how you could tell someone else had worn it. Or, as S2 explains, “a shoe becomes yours once you have worn it in.” While none of the bench participants in this study reported marking the bench, it was obvious that others had etched words or pictures into the paint to leave their mark. This transformation control was a way that users leave a personal mark on the object and thereby make it theirs.

Intimate Knowledge

Ageing is the process of growing with the user. This is related to the literature on aesthetic changes in objects (van Hinte, 1997; Van Nes, 2010) but in this study it specifically relates to the interaction between the object and the user. These interactions often result in dents, scratches and stains that are associated with stories of use. Seldom does anyone besides the user know the origin of a scratch or dent and so this reinforces a bond between the object and the user built on intimate knowledge. S3 shared the origin of barely noticeable super glue along a shoe seam that came undone and was later fixed. P3 showed the barely noticeable mark on the corner of her phone and recounted the time in which she dropped it. Careful design could determine the extent to which object features may age over time to record and communicate user-object experiences.

Disclosure is the process of the object conveying information, meaning, and/or value. This is unique from ageing in that it describes a state of the object independent of current user interaction. Disclosure may result from the context of the object (environment, period of use, etc.) or the object itself (origin, functions, features, value, etc.). B3 felt an attachment to a park bench because of the proximity to the Peter Pan statue nearby and associated memories. This extra knowledge made the bench “magical” and more than just a place to sit. C3 inherited a family car used by other family members while they were at college. Stories from previous users were carried in torn fabric, dents, the odometer, and other features. The miles and experiences were then for him to continue. At times, disclosure can be negative as is the case of contamination—the disgust experienced knowing that another has touched an object (Angyal, 1941; Argo et al., 2006). Under car sharing schemes, this seems to be one impediment to individuals developing a sense of ownership over the cars (Bardhi and Eckhardt, 2012). Contamination comes from a number of sources and should be carefully mediated in design (Baxter et al., 2016a).

Periodic Signalling is the process of object communication on an event-dependent basis. Periodic signalling provides a source of knowledge often exclusive to the user. Examples of periodic signalling include the rumble of an engine when stopped for a period (C3), mobile application failure during a particular sequence of use (P2), and the squeak of a shoe when wet (S3). In these cases, the individual seemed to gain a more intimate knowledge of the object because of a quirk subtle enough that someone not familiar with the object may not notice and certainly would not anticipate.

Enabling is a principle reflecting the meaning carried by those objects directly mediating meaningful experiences. Participants often described objects in terms of what they afford for the user: the car that I take on road trips (C1); the bench that allows me to retreat from the city (B1); the phone that lets me stay connected (P1, P2); the pair of shoes I use for running (S2). The knowledge in these examples seems to be that these objects are used to create meaningful experiences. This is useful even if the experience is not planned as is the case with a road trip (C1). In essence, the knowledge that an object provides control to do something or to fulfil a desired self-image makes it more yours.

Simplification of external stimuli can allow greater opportunity to bond with the object. It is not likely that consumers can develop relationships with all or even many objects due to the required effort. Eliminating or minimising other interactions can help focus attention on the object at hand. This can be done through many design measures. The hectic nature of commuting on public transport can become much more peaceful with headphones. Two users commented that with headphones, distractions were quieted leaving much more focus on the audio coming from the phone (P1, P3). Riding in the car with C1 and C4 showed a dramatic reduction in external noise (particularly in the city) and a greater focus on internal stimuli such as music being played. S2 and S3 discussed how their workout shoes were one of only a few items used during exercise. In the case of the park bench, simple environments were sought (B1, B3) which already made the bench one of the only objects with which they could interact. Eliminating stimuli focuses on the objects at hand and allows for greater interaction, and therefore knowledge, of those objects present.

Proximity to the individual is one way to increase the likelihood that a person more intimately gets to know the object. All phone and car users, for example, could identify subtle features that would be missed if the object was not close to the person. Shoe features, such as a point where the fabric had worn, were reported inside the shoe (S1, S4) that could only be felt. Many objects require proximity by their very nature (e.g. one sits on a bench, a phone goes in a pocket close to the skin, a shoe covers a foot, you completely enter a car). Designs can also encourage close contact such as earphones entering the ear. Proximity enables people to identify subtle features that would otherwise go unnoticed.

Self-investment

Creation can be regarded as the process of bringing something into existence. Users can create an object from scratch or participate in some level of co-creation (e.g. personalise the object). Money, representing effort, is exchanged for goods and may also invoke feelings of creation (Sartre, 2012). Involvement of users in the creation process has been explored (Franke et al., 2010; Mugge et al., 2009; Norton et al., 2011). This study found several examples where aspects of creation have contributed to feelings of psychological ownership. S2 noted how simply changing laces made the shoes more his. All phone owners commented on the value of personalising the phone in many ways. C4 had upgraded his vehicle after

purchasing it making it uniquely fitting his needs. Two bench users (B1 and B3) were particularly interesting in this regard since they went far out of their way to create a desired experience (meditation, reflecting or otherwise escaping from the city) that was facilitated by the bench and its context. This affordance principle is related to control principles, but differs in a focus on the effort required by the user. An example would be when a user delays gratification for a future reward. In such a case, the user is showing effort (resisting instant gratification) for a reward rather than temporally controlling the use of the object.

Repair and Maintenance of an object requires investment from the user to sustain value over time. All four car owners reported repairs and maintenance which seemed to solidify investment in their car. P3 reported breaking a phone and having to replace the screen out of warranty which created closer attention and care. S1 discussed the time and effort that goes into polishing shoes. Many of these activities are what McCracken (McCracken, 1986) referred to as grooming rituals—an activity used to keep special possessions in the best condition possible. The investment required to maintain objects increases interaction and a sense of ownership.

Repository refers to the collection of valuables within the target object. As consumers use objects to store valuables, the object itself becomes valuable and a means to protecting additional parts of themselves. These stored valuables can be physical (e.g. in a car), or digital (e.g. in a phone). C2 used her car as a repository for her child stroller, baby bag, car seat, and many children toys. Great effort had been spent in transforming the car into a place where she felt she could take care of her child. Phone users spend significant effort storing information in the repository of their phone. Collecting contacts, photographs, videos and other information were all tasks that made a phone unique to one user. Interestingly, this meant that phone users felt ownership over the software contained within the phone and not the hardware. “Look at these two phones” P1 said referring to his iPhone 4s and an iPhone 4s owned by one of the authors. “They are identical unless you turn them on”. It is the content created within the software that distinguished them from each other.

Emblems signal information about the user’s identity. The object, brand, and object features can all be emblems. Most participants were conscious of emblems signalling their efforts or stage in life. “An old car with high miles is expected since I am still a student and money is

tight” commented C3. P1 and P3 both noted that they enjoyed the phone but also used it to “look the part” in their professional lives. S1 and S2 reflected this same sentiment of needing to fit in with others. Participants used the objects to show who they are or who they are trying to be. They take possession of the object to extend their self-identity (Belk, 1988a).

Preference Recall is the process of remembering settings determined during previous use. People put effort into making an object theirs by configuring it the way they like. When an object can recall preferences, it allows the user to immediately step back into what they have already created as theirs. P1 reported having significant attachment to the content of the phone but essentially none with the hardware. This is partially because preferences that make the phone theirs are based in software and are easily transferred to new phones. Both C1 and C4 had cars shared among multiple users. The car would adjust preferences (radio stations, mirror positions, seat position, etc.) depending on which key was used. This allows users to quickly step into the environment they have created. Design can use technology to remember preferences established by users.

Discussion and future research

This study has presented a framework for object attachment based on psychological ownership. The work presented in this chapter contributes to design knowledge by providing a holistic understanding of object attachment based on the identification of 16 affordance principles. Previous studies have identified various elements of this framework (Jung et al., 2011; Mugge et al., 2006) but have fallen short of clearly defining the motives, routes, and affordances to psychological ownership. As shown in Figure 4-1, these are straightforwardly mapped to interaction and experience design models and provide a practical resource for designers.

The affordance categories provide interesting commentary on the user-object interactions found within this study. Control and self-investment affordances generally require active interaction where users are influencing the object. This contrasts with knowledge affordances that are largely passive and rely on the object influencing the user. Accordingly, the categories of control and self-investment require the active skill of performing a task, and the category of knowledge requires the passive skill of perceiving communicated information. Understanding this distinction aids in considering design decisions. Active interaction requires

design features that allow users to influence the object by, for example, changing the object in some way. Passive interaction, however, requires object features that communicate to the user such as a careful selection of materials, geometries, and colours.

Object attachment should be considered within the context of the entire user experience. Designers and previous users shape the target object and the affordance principles discussed earlier. Designers may directly control object affordances but have much less control over a user's time constraints, cultural meaning, use environment, and mental state. Thus, it may be useful for designers to consider affordance principles within appropriate levels of engagement. There are potentially four levels of engagement: feature, product, context, and experience. An example of feature-level engagement is the repository affordance principle that is based on components of the product. Spatial control is an example of product-level engagement where interest is focused on how a user moves the entire object. Contextual engagement includes principles that reflect culturally or otherwise context-specific knowledge such as disclosure and emblems. At the experience level, designers need to consider how the larger user experience impacts the relation with the object as seen with the enabling principle. Investigating the levels of engagement associated with the affordance principles may lead to greater insight during the design phase.

This study highlights the need to carefully specify the target of attachment. Phone users reported strong attachment to elements contained in the software rather than the hardware. This is because the software was the target (controlled, intimately known, and self-invested). Designs with multiple components, such as hardware and software, benefit from this in that updated hardware is sold periodically but consumers are enticed to stay with the present organisation given the attachment to the software.

Neither the routes nor the affordance principles are mutually exclusive and attachment will likely increase if used together. The objective, however, is not to maximise these but to optimise them. It is easy to see how maximising affordances could lead to a complex and burdensome interaction that may be too daunting for the user to engage with. Optimisation strikes a balance between affordances and constraints to reach the best way to engage users. User testing should be conducted throughout the design of any product to validate design decisions.

It is increasingly important to provide individuals with meaningful experiences that fulfil fundamental needs. The first step in fulfilling needs is to understand the process that individuals go through when interacting with or experiencing products. The present study provides the psychological framework to fulfil three needs—efficacy and effectance, self-identity, and having a place. The examples collected through the 16 documented interactions put the framework in context.

Objects and participants were chosen to get a variety of interactions resulting in many design affordances. A different combination of objects may have highlighted other affordance principles not seen in this study. The number of objects and participants in this study then act as a limitation in the number of identified affordance principles. The current research is not intended to be exhaustive but rather to act as a step towards better understanding how attachment is developed through the motives and routes to psychological ownership.

The bridge from needs to specific behaviours resulting from this research acts as an aid for design researchers and practitioners. Researchers may use this to build on and consolidate previous work on attachment and to inform further understanding of the nuances between actions, affordances, routes, and motives. Practitioners benefit from a framework upon which they can understand and assess consumers' attachment to their offerings. Future work should move beyond the framework to develop a prescriptive design method. One possible approach is to synthesise questions to guide design activity. An example of such a tool is the Design with Intent method (Lockton et al., 2010), which helps designers reflect and consider design features at the conceptual stage of design based on guiding questions. Another possible prescriptive design method could help designers identify affordance principles with a target group of users or objects and systematically apply the identified affordance principles to other users. This approach would be similar to that of Srivastava and Shu (Srivastava and Shu, 2013).

Future research could also apply psychological ownership to various present topics of interest. Such work would extend beyond an examination of circular possessions. For instance, this model may be useful for informing attachment formed by designers to their concepts or the extent to which students take ownership of their education or design projects.

4.3. Study 3: Keeping and Discarding

Background

Building on the findings of Study 2, this study examines the link between psychological ownership and decisions to prolong a product's life or discard an object. This study also examines the link between psychological ownership and consumer willingness to engage in access-based consumption models. This investigation into keeping and discarding is fuelled by three main research questions to evaluate psychological ownership as a means to address access-based consumption and developing object attachment for product longevity.

- RQ1: Are desires to keep products (rather than dispose) guided by the motives in psychological ownership and fulfilled via the routes?
- RQ2: Are desires to dispose of products determined by an object no longer meeting these motives?
- RQ3: Can reluctance (willingness) to engage in second-hand acquisition and access-based consumption be understood through the perceived failure (ability) of an offering to fulfil the motives within psychological ownership theory?

Through answering these questions, the hope is to inform future directions in researching and designing strategies for circular consumption models.

Methods

This research was based on in-depth interviews with ten participants. Participants consisted of six females and four males, aged from early 20s to late 60s. All interviews were conducted in London, England though the participant's cultural backgrounds consisted of 8 countries through North America, Asia, and Europe.

The intention of the interview was to understand psychological ownership theory as applied to product longevity and access-based consumption. To explore this, semi-structured interviews were used to inquire about interactions with objects: 1) kept for a long time, 2) disposed though still functional and 3) used previously either through second-hand acquisition or access schemes. Participants were asked to identify one or multiple objects in each of these three categories and reflect on them. The choice of the object discussed was left up to the participants. Objects explored included: antiques, consumer electronics, clothing, furniture, and spaces. In each interview, questions regarding the motives and routes of psychological ownership explored nuances of the user-object relationship. Further

questions tried to qualitatively assess the extent to which participants felt the object was 'theirs'. Where possible, interviews were conducted in the participant's home or work where objects discussed could be seen and described in greater detail.

Each interview was documented through notes and audio recording. Directly following the interview, notes were reviewed and any insights or themes were recorded. Recordings were transcribed and all resulting data was analysed in an iterative process to extract emergent themes. All names have been changed to preserve anonymity of respondents.

Two limitations of this research are worth noting. First, the study's findings are limited by the number and background of participants. Ten participants are not enough to understand the distinctions caused by personal values and cultural influences. Second, the study is limited by the number of interactions examined. The way a person interacts with consumer electronics differs from a pair of shoes. Future studies will need to address these limitations in order to further validate the extent to which this framework can be generalized. One useful future approach could use quantitative methods to measure differences in keeping, caring and discarding. The present study seeks to provide initial understanding with this work before more can be done.

Results and discussion

Interviews revealed a strong agreement between psychological ownership theory and participants' rationale for keeping, disposing, and engaging with objects. Perhaps equally important, no participant gave reasons that could not be understood in the context of the theory. The interviews also highlight psychological ownership theory's usefulness in describing why consumers choose ownership rather than access-based consumption schemes. The next sections discuss the findings for product longevity (decisions to keep and discard) and access-based consumption in detail.

Product longevity

All participants reported significant attachment to the objects that they had kept for a long time. Though not always described in terms of feelings of ownership, motives for keeping were consistent with those in psychological ownership theory. The ownership or attachment was only as strong as the object's ability to fulfil the motives and thus, disposal resulted when an object no longer fulfilled the motives. Reasons for keeping and discarding were coded

according to the motives in psychological ownership theory. A sample of the objects discussed and the reasons for either keeping or discarding is found in Table 4-3. Several themes emerged in this regard.

Table 4-3 A sample of kept and discarded objects

Participant	Kept		Discarded	
	Item	Reason(s)	Item	Reason(s)
Laura	Laptop Computer	Place, E&E, Identity	School Documents	Place
Shirley	Wool Coat	Identity, Place	Pots and Pans	E&E, Identity
Vanessa	Earrings	Place, Identity	Table and Chairs	Place
Brian	Watch	Place, E&E, Identity	Record Player	Place
Ashley	Designer Clothes	Identity, Place	Sofa	Place
Greg	Video Game Console	Place, E&E	Shoes	Place
Matthew	Table	Place, E&E, Identity	Chair	E&E
Thomas	Backpack	E&E, Place	Mobile Phone	E&E
Lucy	'Piggy Bank'	Place	Blouse	Identity, E&E
Nancy	Sewing Machine	E&E, Identity, Place	Figurines	Identity, Place

Reasons for keeping and discarding categorised according to the motives having a place to dwell (Place), efficacy and effectance (E&E) and self-identity (Identity). Where multiple reasons are given, the most important reason is listed first.

The *efficacy and effectance* motive communicate users' ability to influence their surroundings and feel competent. This differs greatly if the object is used as a tool to influence some end task or if the object is an end in itself. If an object is used as a tool, attachment (and subsequent longevity) is dependent on the perceived ability of the object to fulfil a task relative to alternatives. Thus, technological innovation often drives desires to keep or replace objects. Laura described this regarding her laptop:

... I would hate to get a new product. Unless it would enable me in a way my existing product doesn't I wouldn't get it. Even then, [new features need] to be very different. The retina display, for example, had little draw for me.

If an object is an end in itself, the danger is in the user no longer being able to explore and discover new things about the object. Greg, a video game enthusiast, explained that video

games are only useful until he has beaten the game or feels there was little or nothing else to discover at which point he would throw the item away. Matthew shared a similar sentiment about a leather chair he “got bored with” and decided to dispose. Product longevity benefits from design that is complex enough to keep users engaged through continuous discovery.

The *self-identity* motive is susceptible to changes in self-image (e.g. advancing in society, maturing, fitting a new position) and cultural influences (e.g. trends). Objects that span both of these were kept for a long time. Shirley talked about a wool coat that she has had for over a decade. The coat passed with Shirley through high school, college, and a professional career and was used frequently at all stages of life because it has a timeless design. Shirley used it when she was younger because it was pretty but she has since transferred it to her professional wardrobe because it looks elegant and mature. This emphasizes the need to understand and account for when and how self-identity transitions.

The *having a place* motive provides security to individuals through familiar objects. Often, objects in the same setting compete for this motive. For example, small objects (books, accessories, artwork, furniture, etc.) are often considered within a larger object (house, room, car, etc.) and individuals try to reconcile a desired place these provide together. Ashley showed this trade-off when disposing of a large sofa in her flat that did not contribute to the room:

It looks horrible. In terms of hygiene a bit weird. [...] It took up too much space in a small flat which would have been useful. We could have had our living room designed better without the sofa.

From this sample, the strongest motive to encourage product longevity was overwhelmingly that of “having a place” as it offers psychological security. This psychological security often came from cultural emblems (e.g. an object from one’s home country) or when the object reflects specific experiences that create nostalgia. In other instances, it provided a psychological state of mind needed in the moment. Shirley described how clothes help her feel “confidence and in a ready state of mind.” Greg explained that his attachment to his Playstation is largely because of the place it provides:

I can sit down and play the PlayStation but also it gives me that spot, you know I live with my partner, we are comfortable, we are together 24/7 but if I want to I can have my break. [...] I know I can shut the door and put my headphones in and escape.

Routes to psychological ownership help users create or discover meaning. There is a directionality between user and target objects of ownership. Control and self-investment are typically things done by the user to the object, whereas intimate knowledge is the result of the user interpreting information communicated by or about the object. Understanding these directions helps inform various approaches (e.g. co-creation, mass customization, designed affordances, associated service offerings, marketing and promotion) to enhancing attachment or ownership.

The interviews overwhelmingly supported the idea that ownership is a dynamic, time-dependent relationship and that the paths to achieving feelings of ownership are important in understanding the process behind keeping or discarding an object. Several archetypical paths to possession and dispossession were identified through inquiring how users engaged with objects over time and how they felt their attachment changed accordingly.

Paths to possession are primarily determined in three ways. First, significant increases in ownership occur when users engage in focused interactions with an object such as configuring, repairing or researching an object. Second, gradual increases in ownership result over time due to improved ability to control the object, routine effort required in interacting with the object and knowledge received through use. Finally, used objects may create feelings

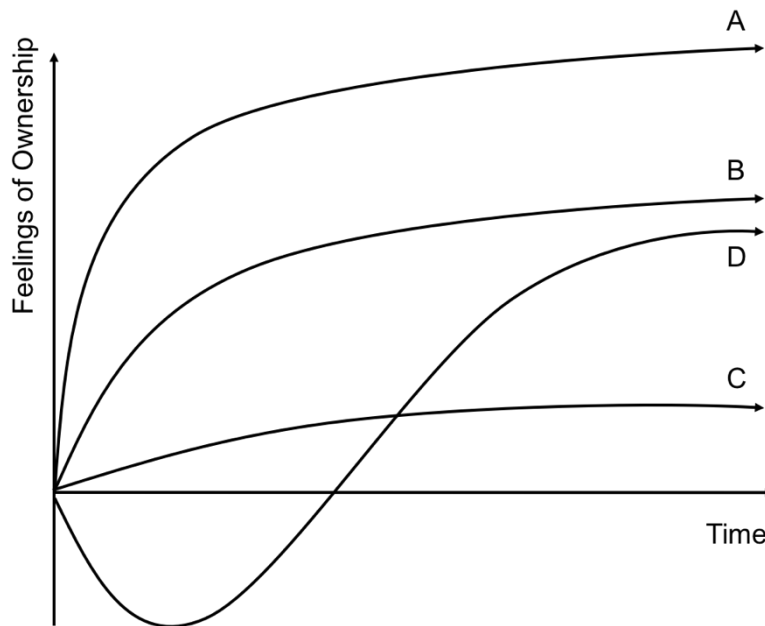


Figure 4-2. Four archetypal paths for developing feelings of possession.

that they are foreign, i.e. belonging to someone else. Four common paths of possession are depicted in Figure 4-2. Path B represents a typical path of ownership for an object—large initial attachment and continued increase as the user learns to better control and cares for the object over time. Path A results from heightened ownership activities (e.g. customization) making a steeper initial feeling of ownership followed by the same general increase in ownership feelings. Path C occurs when the object is standardized so as to limit progression through focused interactions. Finally, Path D occurs when users engage with objects used by other people and feel the object is not theirs until they cleanse it from traces of the previous owner. The height of the end of each line is not intended to be indicative of how all paths occur relative to each other. Instead, these try to differentiate various paths particularly at the early stage of interactions occurring.

These paths are thought to be generalizable as common forms of engagement though they are contextualised here with the example of a car. Path A might represent ownership feelings towards a car that has been customized and is the result of significant up-front work. Path B would be a car as normally purchased. The focused initial interaction in this path being the search for the car and money (e.g. self-investment) spent. Path C might be a company car that a person did not choose or purchase but does get to know through frequent use over time and subsequently develops feelings of ownership for the car. Finally, Path D might be a car

acquired second-hand or temporarily accessed with reminders of the previous user such as smells, markings, or other indicators of use.

Feelings of aversion due to previous users were a common theme in the interviews. Often these feelings result from the sensorial properties of the object and can be accounted for, to a large extent, in design (Baxter et al., 2016a). In other cases, the feeling that an object belongs to someone else is the result of mental associations which are more difficult to deal with and can eliminate the possibility of use altogether. Greg, talking about second hand goods, explained:

I don't think I have ever owned something second hand because... it's bringing someone else's energy into it and I would not have that. I don't have a problem bringing someone else's energy it's just, just not [for] me. I prefer to introduce my energy to anything materialistic.

Paths to dispossession rely on changing user-object interactions as they relate back to the motives of ownership. Similar to possession, four archetypal paths were identified from the interviews, see Figure 4-3 Four archetypal paths for dispossession.. The most common path from this work is that shown by Line E. This abrupt dispossession occurs when a product is made obsolete, e.g. disposing of clothes to buy the newest fashion, upgrading to the latest technology or replacing a broken item. The important element here is that the motive for wanting to own is quickly disrupted. Line F occurs when the product slowly becomes obsolete,

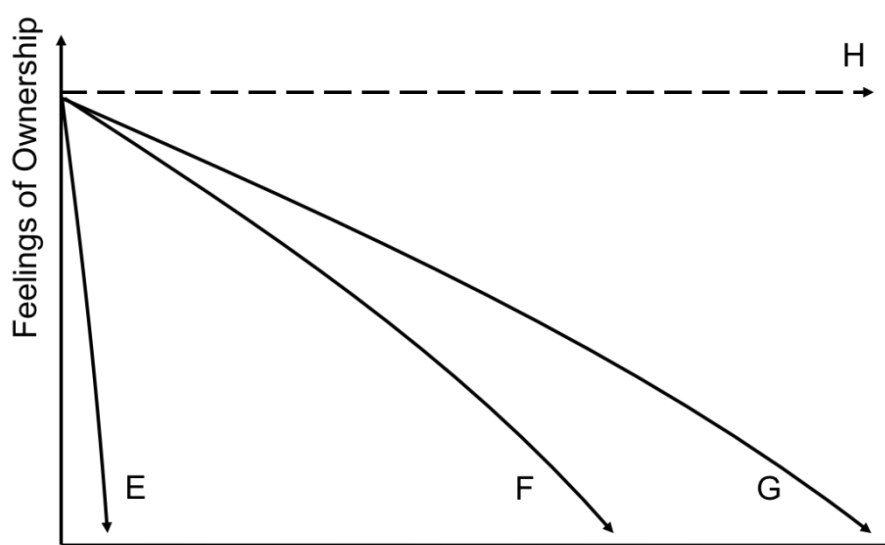


Figure 4-3 Four archetypal paths for dispossession.

e.g. clothes wearing out or a computer getting slow with age. Importantly, this is still an active interaction but the product is less able to fulfil the desired motive. Line G is similar but results from a passive interaction. For instance, it might be an object that is forgotten about and over time grows distant from the user, e.g. a piece of clothing that is left in the closet that may slowly become less in style. Finally, Line H represents objects that are perpetually kept in ownership. The line is dotted because it often occurs with products that are no longer physically around but are kept alive through images, stories or other tools to facilitate nostalgia.

Interestingly, the motive of *having a place to dwell* was the most referenced reason for both keeping and discarding an object. The difference between rationales lie in whether the object provided a psychological or physical space. A psychological space such as reminiscing about nostalgic experiences led people to keep an object. These 'places' are often rooted in emotions and help the person feel safe or secure through familiar objects. Participants reported keeping objects fulfilling their 'place to dwell' for a long time even when it incurred a significant cost. Discarded objects due to the place motive often conflicted with physical spaces. For instance, a sofa that no longer goes with the rest of the living room or documents that take up too much space. This highlights a potential issue as many products were kept simply because there was enough space for them but not because they were serving any purpose. This kind of hoarding could keep possessions from re-entering the system and contributing to the circular economy.

The efficacy and effectance motive is relatively weak because products in this category are often subjected to advances in technology and natural degradation that occurs through use that limits its life. Self-identity is a stronger motive because it is mainly susceptible to major changes in identity that can often be predicted such as transitioning into teenage years, moving to a new house, moving out of a parent's house, going from college to a career, single to married, and so on.

Objects previously used

This section intends to further the discussion started with Chapter 3 regarding psychological ownership's ability to inform access-based consumption. The participants in the study reported a wide range of products previously used. Examples were relatively evenly split

between acquired second hand and accessed products. Just as was the case with decisions around keeping and discarding, decision to acquire second-hand goods related to the motives of ownership. Specifically, participants reported why they decided to get a second-hand item rather than buying it new. Interviews also noted any comment regarding contamination from previous use as indicated in Figure 4-2. The contamination was categorised as: none in which case it was not reported; conditional in which case it was only present because of some reported condition of the object; or strong in which case the participant reported that they would be wary of the used items regardless of the condition they came in. A sample of some of the items reported is given in Table 4-4.

Table 4-4 A sample of items acquired second hand

Pre-used Item	Purpose of using/buying?	Reported Presence of Contamination?
Jewellery, Clothing	Identity	Conditional
Fur hat	Identity	Strong
Faux Fur Coat	Identity	Strong
Record Player	E&E, Place	Conditional
Car Rental	E&E	None
“Never!”	N/A	Strong
Skis and Boots	E&E	Conditional
Television	E&E	Conditional
Car	E&E	Conditional
Baby Crib	E&E	Conditional

Reasons for acquiring used items are categorised according to the motives having a place to dwell (Place), efficacy and effectance (E&E) and self-identity (Identity). Where multiple reasons are given, the most important reason is listed first. Reported contamination is categorised as none if no contamination was reported, conditional if it was reported in this case but participants said it is not always an issue or strong if the participants reported being typically weary of used items.

Access-based objects are, by design, transient and consequently threaten all three motives. Having a place requires developing familiarity with the object so it offers security for the user. Such familiarity is threatened by short-term usage. Typical concerns in this context are around cleaning practices and fear that other users will damage the object. Short-term usage is particularly damaging in that it allows users to engage with an object in a neutral state but it may raise feelings of disgust or aversion because the object was in another person’s place

(the bottom of Path D). These concerns could greatly change object interactions and brand perceptions since the object goes from representing a psychological comfort that contributes to the user's place to a transient condition of use. Vanessa explained such feelings with a coat purchased second-hand that smelt of the previous owner. She went through great effort to remove the smell but those in access-based models may not be willing to invest in such effort. Self-identity is also threatened under access-based consumption due to transient use. This is because in transient usage, objects, and their meaning, are not easily transferred to the user's extended self. Ashley explained that collecting designer clothes helped her—as a fashion designer— “gain a piece” of the designer behind the clothes. Brian explained that he could never rent a watch because he viewed it as having meaning to him and as a memento—an object remembering him that he could pass on to his children. These situations are very difficult under access.

Efficacy and effectance was the clear driving factor behind access schemes (e.g. improve usability and convenience) and when objects only focus on this motive access schemes may be most likely to succeed. An example was Matthew's ski rentals. He used to own his own skis but was discouraged by airline fees and the hassle of carrying them around when traveling. Many years ago, he switched from owning to renting skis once he gets to the resort but he still finds that good service to ensure quality and functionality is essential. This designed service is the key to successful access models. If the service is too obtrusive it causes users to feel that they are no longer in control and their efficacy and effectance are threatened.

4.4. Discussion

This chapter has presented a new framework useful in considering product ownership and attachment. There seems to be much use in the semantics at used here. Attachment, for instance, carries with it strong connotations about a positive feeling occurring. This work has emphasized that this need not be the case particularly when discussing whether they keep or discard the item. Participants reported having many emotions towards an object—happiness, sadness, frustration, excitement, etc.—but still maintained the same fundamental reasons for keeping an object. Importantly, negative emotions and a strong sense of ownership or attachment do coexist. This was most readily seen with one participant who owned an electric tool gifted to him by family. The tool was more than ten years old but was expensive and

would be difficult to replace. In nearly every way this object had strong attachment and a deep sense of ownership and meaningful interactions suitable for circular possessions such as regular repair and careful care. Interestingly, however, the participant said that he hated the object because of the emotion it evoked. Some years prior he had a major difference with the person who had gifted it to him and they ended up parting way on bad terms. Every time he used the object it reminded him of this person and as a result he wanted to get rid of it. This kind of situation emphasizes why discussing things as possessions which are psychologically owned can have much merit as it encompasses the range of relationships people form with an object while avoiding many of the connotations that come with terms such as attachment and emotional bonding.

There are many advantages to enhancing a person's feelings of ownership for an object such as the desire to better care for a product and feel a sense of stewardship for it. In some cases, however, increased ownership will likely have a negative impact. This is in part because ownership gives the feeling that a person can do whatever they please with an object. Anecdotally, this is seen with solar that has been applied to homes. In some cases, homeowners have expressed a feeling that the newly generated electric energy is 'theirs'. The result is that the homeowner invests in new products such as a washing machine, which they otherwise would not have purchased. From a sustainability perspective, this may be problematic since the purchase of the product and use of the generated electricity negates any displaced energy from the solar panels. In such cases, incentives around the result of owning an object (e.g. opportunity to resell, fine for disposal without recycling) might best encourage positive behaviour. From a circular lens this may differ slightly from that of the sustainability viewpoint. For instance, if all the electricity is generated from sustainable sources there is no problem with more consumption since it would remain within circular material flows and fuel the economy.

4.5. Conclusion

This chapter expands on the framework from Chapter 3 to include assessing experiences around attachment and detachment and subsequent decisions to keep, care for, or discard products. In addition to the motives and routes discussed in the last chapter, time-dependent archetypes of the paths followed when developing possession and dispossessing are

presented. Understanding these paths is critical for many design interventions since such interventions intersect at time-dependent touch points somewhere along the path. This aligns and extends prior work in a framework that can be applied to many situations relevant to the circular economy including understanding decisions around product longevity and better fulfilling needs when switching to access-based consumption models. This chapter is intended to provide new thinking for designers and directions for researchers. Further work may attempt to further validate time-dependent trends in ownership and related outcomes.

The prior chapters have partially addressed the aim of the thesis by positioning user possession as a critical element of the circulation of materials and uncovering the value users gain from ownership and how this relates to relevant behaviours. The next three chapters address the final element of the aim which is creating new knowledge around how the perceived value of a product becomes tainted as products move through use and between users. The notion of diminished perceived value was introduced in the present chapter with examples ranging from the aversion people have towards used products that carry a prior user's "energy" to unsavoury experiences with shared cars. These interactions are labelled as contaminated. In Chapter 5, the term contaminated interaction is formally defined and positioned within the circular economy. Chapter 6 expands understanding around contamination to include a typology of what indicates use and how contamination should be considered as a general design construct. Chapter 7 then shows empirical data collected in two studies to show how contaminated interaction can lead to negative outcomes in the circular economy related to proper disposal. Chapter 7 also brings together thinking from earlier chapters in that it addresses the lifecycle thinking needed in considering the design of circular possessions.

5. Contaminated Circularity through Contaminated Perceptions

The discrepancy between the actual interaction a person has with a product and the expected or desired interaction is here referred to as a contaminated interaction. This *contaminated interaction* can act as a major hurdle to material flows—understood here to refer to the flow of raw materials, components, products, or substances (e.g. water)—and the full realisation of the circular economy needs to account for such perceptual barriers of contamination (Hood, 2016). In the retail market this is readily seen through the example of wardrobing—the act of temporarily using an object, such as an item of clothing, and then returning it to the store. The object is used enough that it cannot pass as new but is still returnable. Stores sell these items at a discount, give them away, or discard them. In the US retail industry, the result is an estimated \$16 billion loss each year (Speights and Hilinski, 2005). Treating used objects and substances differently is common. For instance, people rid themselves of worn bills faster than crisp ones (Muro and Noseworthy, 2013) and water, once recycled, may be seen as unfit for consumption (Rozin et al., 2015).

This chapter defines contaminated interaction and positions it as one of three types of contamination within the circular economy⁵. Closed-loop material flows are particularly vulnerable to the perceived meaning of an object and how it changes as it moves between uses and users. Consequently, a case study examination of contaminated interaction's influence on the circular economy reveals four main hurdles to circularity caused by

⁵ This chapter draws on published material (Baxter et al., 2017a) used here in line with the copyright agreement.

contaminated interaction. Each hurdle is discussed in detail. The result is that several barriers to closed loop material flows emerge as objects are avoided, devalued, and misused. This is true of reused, remanufactured, and recycled goods.

5.1. Contaminated Circularity

To contaminate means to make something impure. This assumes that what is contaminated deviates from a pure or undefiled ideal state (Duschinsky, 2011). In the natural world, objects are considered contaminated when something else interacts with them or they are considered for some purpose. For example, a piece of land may be contaminated after a factory has discharged chemicals on it. Likewise, untouched land may be deemed contaminated and unsuitable for human use due to the naturally occurring presence of radon gas which can lead to cancer (Darby et al., 2005; Krewski et al., 2005). In the artificial world, the pure state is designed through human intervention. For instance, raw materials must often be processed to separate the desired products from the undesired by-products (Baumgärtner and Arons, 2003). In this case, the refined material becomes a pure output per engineering specifications. Deviation from this can lead to a perception of an impure and contaminated state. Such deviation is bound to happen as desired specifications change with time or as the material is altered with use. Thus, most material flows begin with some judgment of purity to produce products suitable for use. In closed-loop systems, secondary processing further exacerbates this situation giving rise to incremental impurities. In a circular economy solution where cycling of material flows provides repeated value, such impurities pose an implementation challenge and can add cost or complexity to the cycle or may even invalidate it.

To further understand contamination as it relates to the circular economy a literature review was conducted. The search was carried out using Scopus with the keywords “circular economy”. Emerging forms of contamination were iteratively determined and the search continued until saturation was reached. In total, 82 publications related to the circular economy were reviewed. Saturation was determined when no new forms of contamination emerged and this occurred when approximately 40% of the publications were examined. The review converged around three forms of contamination termed here as technical, systemic,

and interaction contamination. A summary of the three types of contamination is given in Table 5-1 and each is now described in detail.

Table 5-1 Types of contamination within the circular economy

Contamination Type	Definition	Areas of occurrence
Technical	The presence of a contaminant or altered physical property that render material unfit for use	Any point in a material life- cycle
Systemic	The presence of a contaminant or altered physical condition that render material flows inefficient	Throughout system-level processes
Interaction	The presence of some real or imagined property which alters how a user perceives and engages with a material	Any user-object interaction

Technical contamination deals with impurities already existing in objects or those transferred from contact with a source contaminant that renders a material unfit for use. For example, contaminants may enter a factory, be transmitted to workers, or be expelled into the environment (Hojas Baenas et al., 2011). Here the concern is about the fitness of materials for use, i.e. how the presence of contaminants renders raw materials less usable, processed products unfit for use, and the processing of products harmful to people and the environment (Green, 2006; Krook et al., 2006; Yuracko et al., 1997). As such, technical contamination can be considered at any point in the material life-cycle and can be measured and evaluated objectively against a pure state of the material. This pure state is determined and evaluated according to the desired characteristics set forth by companies and regulatory bodies. In a circular system, these evaluations will increasingly be needed within each cycle of use as value diminishes and materials need to be downcycled to relevant applications (Birat, 2015; Haas et al., 2015; Koffler and Florin, 2013; Verhoef et al., 2004).

Systemic contamination is concerned with impurities in the flow of materials within a system. For example, difficulties in separating materials at end of life may lead to impure material mixes that are costly and inefficient to reprocess (Klausner et al., 1998). Here the concern is related to the efficiency with which materials are intended to move within a system (Gregson et al., 2015; Klausner et al., 1998; Ongondo et al., 2013). As such, systemic contamination can be understood through a system-level analysis and is considered against the ideal of how

materials flow within such a system. This problem grows with the transition towards a circular economy. For instance, one hurdle to utilizing discarded ICT components collected and processed for secondary use is that components are often stripped of vital elements before they are donated (Ongondo et al., 2013). Systemic contamination surfaces in material streams, not at the individual product level. The stakeholders most concerned with this form of contamination are those dealing with supply chain considerations in distributing, collecting and processing materials. This is a reason why design for disassembly is a key element of circular economy thinking (Andrews, 2015; Winkler, 2011).

Contaminated interaction is concerned with impurities in an object's perceived value due to prior use. For example, many consumers exhibit widespread repulsion and disgust towards many types of remanufactured products (Abbey et al., 2015b, 2015a). Here the concern is behavioural and deals with how user-object interaction and decision making change as objects move through multiple uses and between users (Andrews, 2015; Bardhi and Eckhardt, 2012; Baxter et al., 2016b; Hood, 2016; Liu et al., 2009). It, therefore, refers to a user-object interaction, which is contaminated because it deviates from an intended interaction or an interaction as it typically exists. As such, contaminated interaction can be understood through an analysis of user-object interactions throughout a system. The interaction becomes contaminated following a real or imagined change in an object's state. Real changes come from physical alterations or contact with some source contaminant. Imagined changes occur with mental associations. The prior interaction may originate as an object gets passed between multiple people, or as it moves through use(s), or may be influenced by an outside factor such as surface changes due to UV degradation. Contaminated interaction can act as a barrier to the circular economy by negatively altering individual decision making. An example of this is the repulsion towards remanufactured products that may disqualify such products from further circulation.

These types of contamination are unique in what they affect and the mechanisms through which they influence the circulation of material flows. The types of contamination can coexist so they should not be viewed as mutually exclusive. Each type of contamination can also occur in isolation. For example, the presence of chemicals in food packaging may make it unsuitable for use but, if imperceptible, will not contaminate user interaction and may not influence the

purity of material streams and influence systemic contamination. All modes of contamination create barriers to the circular economy and should be mitigated. Definitions and effects of the three types of contamination are given in Table 5-1.

The next section explores contaminated interaction as it exists in the circular economy. For contaminated interaction to occur, the perceived change in the object must be meaningful. Meaning originates from an individual's perception of an object, is socially constructed, guides how the object is interacted with, and can change as the object moves through its life (Krippendorff, 2005). Accordingly, to understand contaminated interaction, we must first understand how meaning alters while users engage with objects.

This chapter is primarily interested in how contaminated interaction acts as a barrier to circular flows while the next chapter looks at contaminated interaction as a broader design concept. Notably, contamination is generally negative since, by definition, it is a deviation from a pure or undefiled state, and objects are typically designed to a high specification, which diminishes with time and use. This is exacerbated by a negativity bias in which negative stimuli have a greater psychological effect than neutral or positive stimuli of the same magnitude (Ito et al., 1998; Peeters and Czapinski, 1990; Rozin and Royzman, 2001). There is still value in pursuing positive elements of contaminated interaction and while this is not of primary interest in this chapter, it is discussed in Section 6.5.

5.2. Study 4: Contaminated Interaction in Circular Processes

To understand how contaminated interaction influences circular material flows, 14 case studies were examined, see Table 5-2. The cases were selected to provide a broad view of how contaminated interaction unfolds. Specifically, they cover occurrences of contaminated interaction in relation to vehicles, consumer electronics, clothing, children products, sporting equipment, packaging and more. The knowledge of the cases was developed from published academic literature, formal and informal reports from organisations, user commentary gathered from online blogs or message boards, and primary data collected from observation and interviews with relevant stakeholders. Nine of the case studies involved interviews with either users or service providers, see case studies marked with a star (*). Interviews were generally informal and open ended to explore the facets of each specific situation including what the contaminated interaction was, why it happened, and what the result was for the

users or business. Data and themes were compared across the cases and contextualised within the larger circular economy frame for understanding.

Table 5-2 Summary of contaminated interaction cases examined

Case	Description
Water reuse*	Used water, even if thoroughly treated, is viewed as either not at all usable or suitable for secondary uses only.
Car sharing*	Shared cars often cause negative experiences or are avoided altogether due to the actions of prior users.
Baseball	Baseballs used in a game, if questioned in terms of integrity, are taken out of circulation and used as practice balls.
Toy sharing	Shared toys often raise concerns in parents as they are perceived as unclean and damaged resulting in hesitation to join such programs.
Cloth Diaper service*	Used cloth diapers are accepted by parents only when they have been used by their own child but are considered unsuitable if they have been used by another child though professionally cleaned.
Recycled textile*	Recycled textiles, even when taken down to the fibre and fundamentally reprocessed, reportedly cause disgust and are not being bought.
Wardrobing	Gently used items are returned to stores but can no longer be passed as new and are subsequently sold at a discount, passed on to secondary markets or disposed.
Forklifts*	Remanufactured forklift trucks covered by warranty are still seen as lower quality and are sent to secondary markets.
Mobile phone	Remanufactured phones, despite coming with warranties, are stigmatized leading to phones being sold at a discounted price.
Food processors	Remanufactured food processors are thought to still be unclean even though they have gone through an entire industrial reprocessing.
Packaging recycling*	Used and altered packaging is often seen as waste leading to lower recycling rates.
Clothing take-back*	Used cloths are discarded to second hand stores because they are seen as no longer carrying value.
Littering*	Used objects with altered characteristics influence littering and lead to lower return rates.
Baby equipment*	Used baby equipment exchanged in second-hand markets often see personal parts replaced as they are perceived as unclean.

*included interviews with users or service providers

Three barriers to circular material flows emerged from the analysis of the case studies, namely downcycling, disposal and hindered circulation, see Figure 5-1. The barriers are depicted over a simplified linear economy model in which *raw material* moves into *manufacture*, and *use*, and ultimately becomes *waste*. The return flow entails a circular economy model based on the *reuse*, *remanufacture* and *recycle* of materials. Manufacture refers to the initial manufacturing of a product but can also include services (e.g. facilitated redistribution) or manufacturing needed to reintroduce a product into the market. Use includes both primary and secondary use within the same or alternative markets. The barriers result from individuals' evaluation of new or used objects prior, during, or after consumption. Contaminated interaction is relevant to companies or business to business transactions when individuals in organizations hold biases around contamination. Evaluation of objects is informed by aspects as varied as previous use, other users, accompanying objects, object settings and the perceptible characteristics of the object (Baxter et al., 2016a). The three barriers to circular material flows are now illustrated in turn.

Downcycling: Evaluation prior to purchase and use may lead to products or substances losing their value because of contaminated interaction concerns. This can result in manufacturers

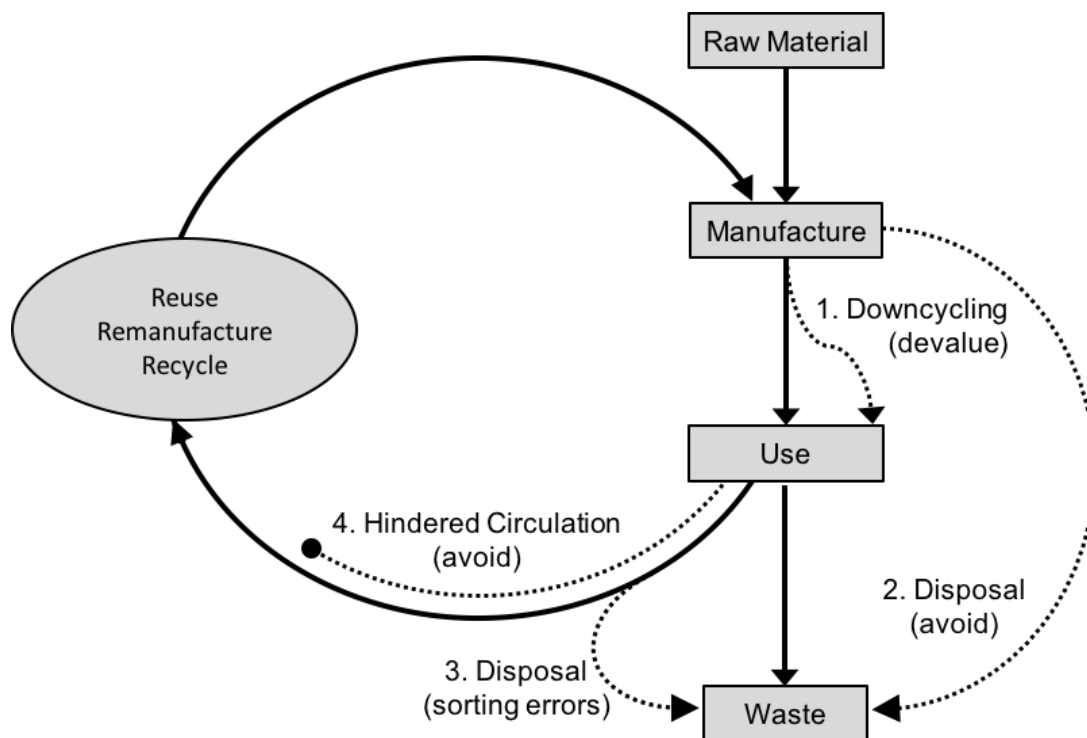


Figure 5-1 barriers to material circulation due to contaminated interaction

and service providers downcycling products to secondary uses and markets, see dotted line 1 in Figure 5-1. Downcycling to secondary uses is common but in this case, differs from standard downcycling in that it is driven by user perception, not an objective change in value. For instance, recycled water is not seen as suitable for domestic use (Gu et al., 2015). Downcycling may also send products to secondary markets, e.g. remanufactured forklifts sent to developing countries. This too is a form of downcycling since the secondary market only claims a fraction of the original value.

Disposal: Premature disposal takes place in two ways. During evaluations of objects prior to purchase and use, individuals may make decisions to avoid products, e.g. an aversion to used clothing due to concerns of contamination. If supply of such products exceeds demand (including demand in secondary markets), the material may be disposed of in the landfill, see dotted line 2 in Figure 5-1. Premature disposal can also result from end-of-life evaluations. At this point, decisions must be made to sort waste objects, e.g. recyclable packaging, so that they are properly returned to the system. Contaminated interaction has the potential to lead to sorting errors that can result in increased disposal of otherwise circular materials, see dotted line 3 in Figure 5-1. This material is prematurely disposed as it is sent to landfill rather than through a circular process such as recycling.

Hindered circulation: Early decisions made by users to avoid products can hinder a business from identifying a sufficiently strong demand to pursue or expand circular business opportunities, e.g. unwillingness to engage in a cloth diaper service despite professional cleaning, see dotted line 4 in Figure 5-1. This includes the creation of new opportunities and the expansion of existing operations.

5.3. Case Studies of Contaminated Circularity

This section presents examples of contaminated interaction through a selection of the case studies investigated, and show how they influence circular processes. Cases of contaminated interaction are considered across three process categories: reuse (Argo et al., 2006; Baxter et al., 2015b; Catulli et al., 2013; Hood, 2009; Kapitan and Bhargave, 2013; Liu et al., 2009; McCracken, 1986; O'Reilly et al., 1984), remanufacture (Abbey et al., 2015b, 2015a; Agrawal et al., 2015; Andrews, 2015; van Weelden et al., 2016), and recycle (Gu et al., 2015; Hood, 2016; Rozin et al., 2015). Each process highlights a specific case where contaminated

interaction occurred, some strategies to deal with it and its impact on circular material flows (see summary in Table 5-3). The cases presented in the chapter were chosen to highlight variations in how circularity is impacted and therefore provide a perspective on the breadth of the phenomenon.

Table 5-3 Featured contaminated interaction cases

Process	Case	Presence of Contaminated Interaction (driver)	User Interaction	Circular Impact
Reuse	Car sharing	Smoke residue in car creating feelings of disgust (hygiene) and infringement of personal space (territory)	Avoid	Hindered circulation
Remanufacture	Forklifts	Perceived to be of lower quality (utility)	Devalue	Downcycle
Recycle	Packaging	Altered packaging is seen as waste and discarded rather than recycled (utility)	Sorting errors	Disposal

Reuse

The European Union Waste Framework Directive defines reuse as “any operation by which products or components that are not waste are used again for the same purpose for which they were conceived” (European Union, 2008). For the purposes of this discussion, reuse includes the sharing of objects among multiple users, the redistribution of objects through second-hand markets, and the extension of a product’s life by continuing to use an object after its initial intended use. Excluded from this category are remanufacturing and recycling operations, which require additional processing capability. The case of car sharing is used to explore how reuse is threatened by contaminated interaction.

Car sharing is a fast-growing trend in which a group of individuals gain access to a set of cars owned by a company. These cars are typically used in urban environments for short trips around a town. The short duration of the trips means that several users often ride the same car in a single day making it particularly susceptible to contaminated interaction.

In a study of car sharing, Bardhi and Eckhardt (2012) found evidence of contaminated interaction. One user described the gross feeling he had when using a car previously used by

someone who had broken the non-smoking ban. This sentiment is supported by community blogs and online reviews. On one blog, an individual reported that 16 of the last 20 times he used a car sharing service the vehicle was saturated in smoke (Petworth, 2016). Smoking residue is a form of technical contamination, which subsequently causes contaminated interaction. At the root of the dissatisfaction felt by these users seems to be a hygiene concern around maintaining personal health as well as a territorial concern around an uncomfortable personal space. The result is that car users are distancing themselves from the overall community (Bardhi and Eckhardt, 2012) or considering different services altogether (Petworth, 2016). This shows how contaminated interaction can lead to service substitution or avoidance.

Car sharing rules act as a strategy to prevent contaminated interaction. For example, when new users sign up to the Zipcar car sharing service they are shown “six rules of the road” to which they agree: report damage, keep it clean, no smoking, fill ‘er up, return on time, and pets in carriers (www.zipcar.co.uk/is-it/rules). Rewards or punishments are used to encourage good behaviour. The company, however, is still unable to ensure satisfactory user experiences in a consistent way, as seen in various user comments (Bardhi and Eckhardt, 2012; Petworth, 2016), resulting in potentially poor brand reflection. This may have the secondary effect of deterring other companies from running similar programs or preventing expansion of existing offerings into additional market segments.

Remanufacture

As the British Standards Institution defines it, remanufacturing is to “return a used product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product” (BS 887-2:2009). This section includes refurbishment and significant repair intended to return an object to a satisfactory state. Remanufacturing is a step below reuse because it requires additional work and raw material to get the object into a usable state. In remanufacture, the object maintains its fundamental characteristics and thus is distinct from recycle. The case of forklift rebuilding is used to explore how remanufacture is influenced by contaminated interaction.

As part of a research project, one of the authors of (Baxter et al., 2017a) worked with a forklift truck manufacturer which was interested in having remanufactured trucks among its offering

to create a more circular business model. A remanufactured or reconditioned forklift truck can cost a fraction of the price of a new unit (Chapman et al., 2009). Remanufacture of a forklift truck includes disassembling it, heat-cleaning it, inspecting components for defects, resurfacing and resizing components and replacing others, reassembling and testing. Buying a remanufactured forklift truck may cause worry and apprehension, however, as there is a risk of pre-existing damage.

The forklift manufacturer consulted explained that remanufacture has significant benefits. Among these is the fact that the product often performs better than new units because most failures happen in the early stages of the product and those would be resolved if the product is still around for remanufacture. Despite this, when discussing the possibilities for remanufacture, the company indicated that users would not be likely to accept a remanufactured unit because of the perceived defects caused during previous use. Wear and defects on used units are changes to the physical aspects of a product, which then cause the contaminated interaction. This reflects a utility concern as it represents a perceived decrease in functional value. The company explained that they would only be able to sell remanufactured units to secondary markets such as those in developing countries. This shows how contaminated interaction can lead to downcycling in terms of market.

Strategies to overcome negative perceptions of remanufactured parts partially deal with addressing perceived risks of acquisition through approaches such as quality assurance (Ongondo et al., 2013; van Weelden et al., 2016). In other cases, however, there is much less that can be done, e.g. remanufactured food processors perceived as disgusting and unfit for secondary use, in which case it is recommended to turn attention to recycling and recovery of materials from the product (Abbey et al., 2015b, 2015a).

Recycle

The European Union Waste Framework Directive defines recycling as “any recovery operation by which waste materials are reprocessed into products, materials or substances whether for original or other purposes” (European Union, 2008). Within the scope of recycling is included the operations of disposing, collecting, sorting, and subsequently reprocessing materials and substances. Recycling is considered to be energy intensive and is, therefore, the lowest option

of a sustainability hierarchy (EMF, 2013a; European Union, 2008). To explore how recycling is influenced by contaminated interaction, common packaging disposal practices are examined. The familiar nature of many recyclables means that high rates of correct recycling is typically achieved in developed markets. However, as objects move through use, their size, shape, colour, or other characteristics may be altered. In turn, this can lead to changes in what the object means to the user and how the user interacts with the object. Such changes significantly alter the subconscious categorization of packaging from recyclable to trash (Baxter et al., 2016b). In a study of disposal behaviour, commonly recycled objects, once altered, have been shown to be recycled less than half as frequently (Trudel and Argo, 2013). The changed meaning of commonly recycled objects shows two forms of contamination. Contaminated interaction emerges as the intended interaction with the object changes due to some prior modification made upon the object. This is unique in that it is a case of self-contamination since the individual disposing of the object is often also the one who alters the object during use, e.g. tears a paper or crumples a can of soda. In this case, the fundamental value of the object is diminished in the eyes of the user representing a form of utility concern, which then leads to sorting errors. Systemic contamination is also shown since the object can be erroneously sorted and thus does not adequately enter the value stream.

Three strategies are identifiable to deal with this. First, signage on the bins could be changed to resemble altered objects to nudge proper sorting (Trudel et al., 2015). The packaging itself might also be redesigned to control transformations undergone during use (Baxter et al., 2016a). A third strategy would be to make disposal a more conscious endeavour.

5.4. Discussion

This research has made a case for contaminated interaction as a barrier to circular material flows. Contaminated interaction was shown to stem from variations in the perceived state of a material and driven by concerns over hygiene, territory and utility. This form of contamination can hinder the circulation of materials, result in downcycling or lead to premature disposal. These barriers were identified from examining 14 case studies and shown to influence decision making by individuals in consumer and business to business environments. This list of barriers is meant to be exhaustive but further research should validate the existence of the barriers in more situations. Technical and interaction

contamination are expected to share the same barriers and differ only in evaluation context (i.e. what is being evaluated and by whom). Systemic contamination, like technical contamination, can be objectively assessed though this is expected to primarily deal with the efficiency of material flows.

In direct analogy to current thinking in industrial ecology⁶, contaminated interaction needs to be addressed in several ways. Methods should be identified to limit or eliminate contaminated interaction at a *design, use, service* and *policy* level.

Design processes should consider how object meaning changes with multiple uses and users. This follows the call for emotionally durable design—a form of sustainable design that enhances the durability of relationships between people and products to reduce consumption and waste (Chapman, 2005). The present research suggests that an expanded approach is needed to consider how to design products that easily transfer between uses and users while maintaining high perceived value. This *experientially transferrable design* considers emotional durability but also the resilience with which a product can be used by multiple people and maintain a positive (or at least neutral) user experience. An example of this is seen in cars which adjust mirrors, seat positions, radio stations and other settings to a specific driver helping develop feelings of ownership and personal space (Baxter et al., 2015a). This assisted personalization helps car sharing users have a more pleasant experience.

In terms of *use*, some interventions are focused on setting and monitoring behaviour. For example, communities in which multiple users share spaces or products, such as Airbnb and Zipcar, increasingly rely on rules explaining how objects are expected to be used. Financial or social penalties, e.g. fines or bad reviews, are set up to discourage misuse. In other examples,

⁶ The development of contaminated interaction within industrial ecology shares several parallels to closed-loop development of metal processing as presented by Verhoef, Dijkema, and Reuter (Verhoef et al., 2004). For instance, just as the impurities in a few ores (zinc, copper, and lead) shaped the industrial infrastructure for metals processing, some key cases of contaminated interaction will likely shape human-facing processes of the circular economy. This will include the treatment of materials before use, the information kept about specific materials and their histories as well as terms of use of objects. Just as with metal processing, the development of such an infrastructure will require the close collaboration of designers and operators. Finally, contaminated interaction will likely follow metal processing in terms of the depth of understanding developed around circular processes.

simply monitoring user behaviour is a strategy to reinforce appropriate use. Installing smoke detectors, CCTV or human monitoring systems are all examples of this. Finally, interventions may also prevent object changes in use, e.g. through designing for durability as is seen with the relatively more durable bicycle design used in bike sharing programs.

Services can help to return contaminated goods to a valuable state. Some physical elements of contaminated interaction may be addressed through common practices such as cleaning and maintenance. However, this is just one aspect of the problem. The non-physical elements of contamination may be much harder to address (Abbey et al., 2015a; Hood, 2016). In these situations, it may be necessary to provide users with selective information. Online shops often provide substantial information to assess the quality of a product. It is important to appropriately communicate other indicators of quality. This communication requires further examination since some tactics, such as labelling the item as 'good as new', have the adverse effect of making people think about how someone previously used it (Ackerman and Hu, 2016).

Policy should do more to protect buyers and sellers from the adverse effects of contaminated interaction. An example comes from the buying and selling of homes. Sellers are typically required to disclose any material defects that could influence purchasing decisions to protect buyers. Such defects are typically considered in a physical sense (e.g. damage to the home) but may also include psychological defects of so-called stigmatized properties (Alias et al., 2014). A stigmatized property is "psychologically impacted by an event which occurred or was suspected to have occurred on the property, such even being one that has no physical impact of any kind" (Morgan, 1994). Property stigmas can come from any number of factors such as criminal activity, murder, diseases carried by the previous owners, and, in some cases, even the presence of ghosts (Reilly, 2000). In the US, about half of the states have laws regarding stigmatized property and these most often protect the seller from any liability if they fail to disclose such issues (Larsen and Coleman, 2001). Similar treatment is given to other stigmatized goods that might otherwise be circulated⁷.

^{7 7} For instance, eBay restricts sellers from listing objects owned by murderers or Nazi leaders (see the list of restricted items on www.ebay.com). Bruce Hood also discusses many

5.5. Conclusion

This chapter distinguishes between three types of contamination in the circular economy. Technical contamination is about an objective assessment of fitness for use. Systemic contamination is about understanding system-level purity of material flows. Contaminated interaction is about assessing changes in perceptions and behaviours due to some real or imagined contaminant. Though not always with these names, technical and systemic contamination has been considerably explored in the literature. Alone, these provide an incomplete picture of what contamination means in the circular economy. Through the examination of case studies in and out of the literature, this chapter acknowledges the need to identify purity of perceptions and behaviours to achieve desired circulation.

contaminated goods perceived to be unfit for use from homes of murderers to clothing owned by the same (Hood 2009).

6. Contaminated Interaction

To overcome contaminated interaction, circular possessions should be designed such that they maintain meaningful interactions across uses and between users. In Chapter 5, contaminated interaction was positioned as a threat to circular material flows. Chapter 6 now develops foundational knowledge about the underlying causes of contaminated interaction. This chapter consists of two studies⁸. The first, Study 5, investigates what indicates use and which indicators lead to aversion. This is primarily focused on material properties and how these sensorial properties evoke feelings in the users. This study identifies a typology of indicators of use and identifies three categories that contribute to contaminated interaction: hygiene, utility, and territory. Study 6 continues the investigation into contaminated interaction and develops an ontology against which contamination can be categorized. This is substantiated with positive and negative instances of contaminated interaction discovered through user interviews.

6.1. Broadening the understanding of Contaminated Interaction

In the early 20th century a single ball would be used for the better part of a professional baseball game in the United States. At that time, pitchers would often try to impair the batter's visibility by spitting on the ball with tobacco-laden saliva while at the same time try to improve their control of the ball by altering the surface of it through scratching or other means (Childs, 2011). These altered balls became known as "spitballs" (James and Neyer, 2008). For many pitchers, the spitball was critical to their careers as it gave them an edge over

⁸ Significant elements of this chapter are published elsewhere (Baxter et al., 2016a; Baxter et al., 2017b) and are used here under the personal use clause of the copyright agreement.

the batter. For batters, however, the impaired visibility was problematic and, in at least one instance, may have led to a fatal incident (Hample, 2011). Organized baseball has long since banned any ball tampering and has become very sensitive to any imperfections on the ball. The result is that a single ball lasts only a few pitches before it is deemed unfit for use and taken out of the game as to avoid tainting fair play.

The baseball example speaks to a larger subject of how increases in use and users can lead to contaminated interactions. As mentioned in the previous chapter, contaminated interaction is the idea that an interaction with an object can differ from its natural or intended condition due to another interaction by someone or something.

Examples of contaminated interaction include but go beyond what was discussed in the last chapter. Shopping habits change when others are present (Luck and Benkenstein, 2015). Worn and crisp currency are spent differently (Muro and Noseworthy, 2013). Altered recyclables are mistakenly sorted as trash (Baxter et al., 2016b; Trudel et al., 2016b; Trudel and Argo, 2013). Recycled water is avoided (Rozin et al., 2015). Remanufactured items are seen as disgusting (Abbey et al., 2015a, 2015b). Shared product quality is questioned (Liu et al., 2009) or negatively experienced (Bardhi and Eckhardt, 2012; Petworth, 2016). Finally, objects owned by celebrities appreciate in value (Argo et al., 2008; Hood, 2009; Newman et al., 2011; Newman and Bloom, 2014) while those owned by criminals are often destroyed (Hood, 2009). Contamination directly influences perspectives on the future way of living and will thus impact the values associated with sustainability (Blevis, 2007).

Contaminated interaction extends to the digital sphere as well. Facebook users are influenced by the presence of their parents and others on social media (Barrett, 2015; Brandtzæg et al., 2010). eBay restricts the selling of items owned by murderers or Nazi leaders (see restricted items list on www.ebay.com). Youtube star PewDiePie deactivated his comments section for a short time due to the amount of spam making it not possible for him to interact with fans (Stuart, 2014). Facebook has developed tools to help people detach from former partners without the discomfort of constantly seeing joint content (Winters, n.d.). Several high-profile people have left social networks following a series of negative or even abusive experiences (Cohen, 2014; Gibbs, 2016). Amazon has filed lawsuits against fake reviewers in an attempt

to establish the integrity of its processes (González, 2016). A move that may be particularly important given the disproportionate bias users give to reviewers (Langhe et al., 2016).

The presence of contamination is further seen in design interventions intended to prevent it. Noise cancelling headphones allow us to better focus on work. Facemasks are used in an attempt to breathe more safely outside despite air pollution. Social media allows you to block people with whom you do not want to interact. Finally, paper towel dispensers are made to be used with your elbow to avoid contaminating your hand. All these examples highlight the need for a better understanding of contaminated interaction.

6.2. Perceiving use

Any attempt to mitigate contaminated perceptions should begin with an effort to understand how such perceptions occur. Used objects typically vary in some way from their original state. This variation is perceived through signs or indicators (Krippendorff, 2005). Such perceptions are important in understanding user experiences and behaviour. Indicators of use, for example, contribute to replacement decisions by consumers (Van Nes, 2010). In addition, they also play an important role in evaluating and acquiring second hand goods. Virtual marketplaces, such as Amazon.com, eBay, and AbeBooks, rely on sellers to detail the condition of the objects on sale to help buyers make informed decisions. This type of shared knowledge is common of many evaluations. While the virtual marketplaces may rely on sells describing the actual condition of the book, other types of knowledge may be implicit or assumed by the user such as how or who they believe previously used an object even if it shows no signs of wear. This contrasts with brick-and-mortar stores offering used goods that allow consumers to personally inspect the object and judge the quality of the goods. Consumers in these cases inspect objects through sensorial properties—things that they can see, smell, touch, hear and taste. Understanding these properties is important to help consumers make informed valuations (beautiful/ugly, clean/dirty, functional/broken, etc.) and subsequent decisions about acquiring, using, or disposing of an object.

Research around consumer perceptions and evaluations of sensorial properties has received significant attention recently (Atkinson et al., 2013; X. Chen et al., 2009; Xiaojuan Chen et al., 2009; Forslund et al., 2013; Georgiev and Nagai, 2011; Karana et al., 2009, 2013; Karana and Hekkert, 2010; Krishna, 2012; Nagai and Georgiev, 2011; Schifferstein, 2010; Wastiels et al.,

2012a, 2012b; Wastiels and Wouters, 2012). These studies generally focus on linking some sensorial property to user reactions and evaluations. In the case of used objects, the focus has generally revolved around designing positive, enduring object evaluations (van Hinte, 1997). Power tools, for example, have a rugged image that is reinforced by the nicks and scratches that they sustain in use (Park, 2010). This narrative or story told through changes to the surface of a material is referred to as the patina (Giaccardi et al., 2014; Odom et al., 2009; Odom and Pierce, 2009). The patina reflects both man-made and natural changes to the material. A similar concept is that of “beausage”, an ungainly and possibly unsuitable moniker given its rhyming connotations, formed by the combination of beauty and usage that refers to the beauty developed through consistent use (Petersen, 2012).

The focus on creating objects that age well reflects a sentiment of improving the object’s meaning over time by understanding the product’s signs related to the users (Krippendorff and Butter, 1984). This type of work, focused on ‘designing in’ features that make positive interactions, may often overlook the important step of understanding and ‘designing out’ features leading to negative interactions. Negative interactions may result for multiple reasons. Creating a patina, for example, may enhance meaning for a user who understands the narrative, but may create a barrier for another user who sees traces of use by another person. Understanding the factors related to negative interaction including feelings of aversion is increasingly important as technology enables larger second-hand markets. Still, previous work has largely overlooked issues of this nature (Pierce and Paulos, 2011).

6.3. Contamination

Contamination is the process through which the quality, meaning, or value of an object change due to interaction with someone or something. As such it implies that an object has been used in some way and it often leads to apprehension towards or aversion to the object. Aversion to objects touched or used by others is not a new concept. Conducting an in-depth study of the indigenous people of New Guinea, Anna Meigs found that members of a community will not consume food produced or served by a woman who marries and relocates to that community (Meigs, 1984). The belief is that some of the woman’s essence has transferred to the food and the members of the community will be ‘polluted’ with her properties if they accept it. This idea of a foreign or unclean object contaminating a target

object is reflected throughout cultures. Several Biblical accounts, for example, reflect the transfer of 'essence' from a source to a target through the literal or figurative act of touching an object or being⁹. This transfer of essence has been described under two related "laws." The "laws of sympathetic magic" suggest that a source magically transfers some of its properties to the target through touch (Mauss, 1972; Nemeroff and Rozin, 1994) and the "law of contagion" states that a source will continue to influence a target even after it stops touching it (Rozin et al., 1986; Rozin and Nemeroff, 1990).

A related area of research is that of interpersonal contamination. Goffman has presented six modes of interpersonal contamination: (1) violation of personal space, (2) touching or bodily contact, (3) glancing, looking and staring, (4) noise pollution, (5) talking to or addressing, and (6) bodily excreta (fluids, odour, body heat, markings left by the body) (Goffman, 2009). Belk has added to this list the acquisition of possessions of another person that have been intimately associated with that person and has described contamination as one of the ways in which a person can incorporate an object into the extended self (Belk, 1988a). As expected, the sensitivity of individuals to interpersonal contamination varies significantly (Rozin et al., 1994) according to one's relation and history to the contact source (Rozin et al., 1989). Nemeroff showed this in a study in which participants were asked to draw germs as belonging to themselves, a stranger, a lover, or a disliked peer. Lover's germs were depicted as less threatening than disliked peers' germs. Participants said that they were as likely to get infected from all individuals but the severity of the illness followed a linear trend least severe with a loved one and most severe from a disliked peer (Nemeroff, 1995).

The notion of contamination has important practical implications. It influences simple and even subconscious behaviours in day to day living. An example is the act of avoiding seats on public transportation or in a café that appear unclean. In a larger context, contamination can prevent acquisition intentions (Liu et al., 2009; O'Reilly et al., 1984), negatively impacts interaction (Bardhi and Eckhardt, 2012), and decreases the valuation of the product (Argo et al., 2006). Contamination can also prevent consumers from taking possession of an object. In some cases, consumers cleanse the object of any sign of previous use before taking

⁹ Examples include Leviticus 11, Deuteronomy 23, Isaiah 52, Matthew 8, and Luke 8

possession of it (McCracken, 1986). These negative consequences of contamination present major barriers to the diffusion of second-hand markets and sharing schemes such as product-service systems.

The research in Study 5 is limited to negative contamination mediated by used objects. This excludes related topics such as positive contamination (e.g. a desire for things used by celebrities or attractive people (Argo et al., 2008)), aversion to inherently disgusting things (e.g. bodily fluid, specific colours), and contamination resulting from direct interpersonal conditions (e.g. contaminated personal space). Some of these other factors such as positive contamination and sources of contamination are explored in more detail in Study 6.

6.4. Study 5: Indicators of Use

The aim of this study is to understand the origins of perceived use and contamination to help designers create better experiences with objects. Though several factors surely influence the perception of contamination, materials are expected to be one of the most significant. When interacting with objects, materials stimulate users' senses and contribute to the meaning-making process together with other factors such as shape and context. An example of the importance of the sensory stimuli produced by materials is shown by Schifferstein (2009) who looked at how containers made of different materials (e.g. glass, metal, and ceramic) impact the resulting experience of drinking. In many cases, the drinking experience was greatly affected by the cup material and other sensory perceptions of the cup. Currently there is a growing interest in materials as an experiential factor and research effort has been directed at supporting the understanding and selection of materials for the creation of specific meaning in new goods (Ashby and Johnson, 2013; Georgiev and Nagai, 2011; Jahan et al., 2010; Karana, 2010; Karana et al., 2010; Wastiels et al., 2012a; Wastiels and Wouters, 2012). Use and contamination often rely on consumers' sensory perceptions, thus this study focuses on sensorial properties inherent to materials (e.g. colour, smoothness, etc.) and interaction between materials (e.g. resistance, loudness, etc.).

The aim is accomplished through a two-phase study. The first phase, based on an analysis of used objects, identifies and categorizes indicators of use and their sensorial properties. The second phase links the properties found in the first study to types of contamination. In the context of this study, 'used' refers to objects that have left their new state. Wear is a related

term referring to the physical result of use. 'Indicator of use' includes signs of wear but can also incorporate other aspects signalling use such as contextual factors. Finally, 'contamination' is defined as the process through which the quality, meaning, or value of an object change due to interaction with someone or something. As expected, contamination is most often used in a negative context resulting in an aversion to objects. Though the present study considers this negative contamination, contamination (sometimes referred to as contagion) can occur in a positive light as well. Positive contamination, as mentioned earlier, is studied in more detail in Study 6 later in this chapter.

Results show that indicators of use can be viewed in a typology consisting of five categories: (1) knowledge of previous use, (2) object context, (3) object settings, (4) object characteristics, and (5) object states. Most of the indicators of use studied in this research fall into the object characteristics and object states categories. Corresponding sensorial properties were inferred from the indicators of use recorded by the participants during observations. For example, a stain on a bus seat changes the seat's colouration, while a grease mark on a bus window changes the window's transparency. Sensorial properties in this study differ from previous studies in that they reflect changes from a new to a used state rather than absolute properties. Indicators of use leading to contamination were identified. Contamination was found to be driven by three mechanisms: hygiene, utility and territory. These mechanisms are unique but not mutually exclusive. Insights regarding contaminated interactions are derived by mapping sensorial properties from the first phase of the research to the mechanisms of contamination from the second.

Approach

The approach employed in this research to study the origins of perceived use and contamination involved two phases as illustrated in Figure 6-1. Phase 1 focused on understanding perceived use. It started by collecting a large data set of observations about used objects. For each observation, the principal information component is the indicator of use, which captures the variation of an object from its new to its used state. After data collection, the indicators of use were classified using five categories, which revealed that use is signalled by object characteristics and states more than object settings and context. As expected, these states and characteristics generally resulted from changes in the object due

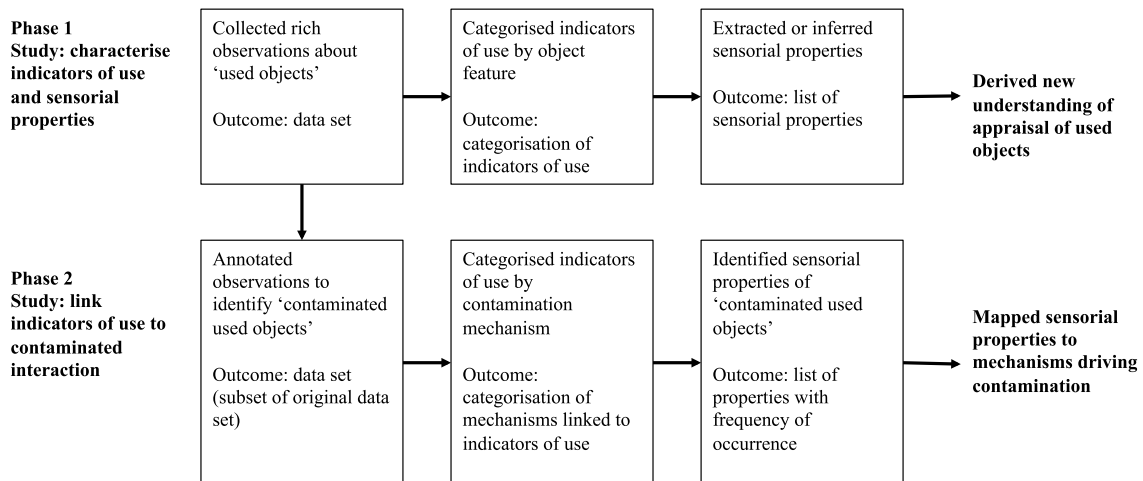


Figure 6-1 Research study approach

to material properties. Fundamental material properties then become important in understanding possible indicators of use and related sensorial perceptions. At this point a list of the sensorial properties underlying the indicators of use was developed based on a previous classification and a general inductive approach to qualitative data analysis.

Phase 2 focused on understanding contamination. During this phase, the observations were further analysed to identify when a used object would also be classed as contaminated. To achieve this, the observations were screened to identify when encounters with used objects would evoke feelings of aversion. Analysis of the indicators of use associated with contaminated used objects led to the identification of three main contamination mechanisms, namely hygiene, utility, and territory. The mechanisms are to be intended as overarching concepts into which each indicator of use can be grouped. The next step consisted of identifying the sensorial properties of contaminated used objects and understanding their frequency of occurrence. Overall the study conducted in Phase 1 delivered new understanding of the appraisal of used objects, while the study conducted in Phase 2 allowed mapping sensorial properties to the mechanisms driving contamination. The combination of the two studies provides an extensive exploration of indicators of use, object-level sensorial properties mainly linked to changes to material properties, and resulting contaminated interaction.

Characterising indicators of use and sensorial properties

The primary objective of this phase of the study is to identify and categorize indicators of use. The study uses qualitative methods of analysis to develop a general typology of indicators of use and identify common sensorial properties. These sensorial properties are perceptual changes between the new and used state of an object and often result from the technical material properties of the object (e.g. hardness might allow a surface to be scratched). After this the research looks at how material or other product features contribute to the perception of an object being used. At the conceptual design stage, materials and other design features can be selected to control indicators of use and mitigate, where possible, contamination effects.

Method

This section details the method employed to characterise indicators of use and sensorial properties.

Participants

Prior to the study, several informal discussions and pilot sessions showed that participants without a design background had a more difficult time fulfilling the task at hand with adequate detail. Thus, participants with a background in design were deliberately recruited. Twenty-one participants engaged in the study. Participants included design faculty members (3), PhD researchers (9), under-graduate or Master's students (7), and design practitioners (2). All participants were living in the United Kingdom at the time of the study but the origin of participants was split relatively evenly between North America, Europe, and Asia.

Procedure

Participants were invited to partake in the study through an email explaining the requirements. The task included attending an initial meeting and then recording observations about used objects and their indicators of use in a provided journal over the course of one day. During the initial meeting a free lunch was offered to encourage participation. Participant information was gathered and all participants were given a pocket-size journal. Each participant was asked to make a minimum of 30 observations indicating that an object had been used. Observed indicators needed to be unique but participants were encouraged to list multiple indicators for the same object. A book, for example, may have a coffee stain, a

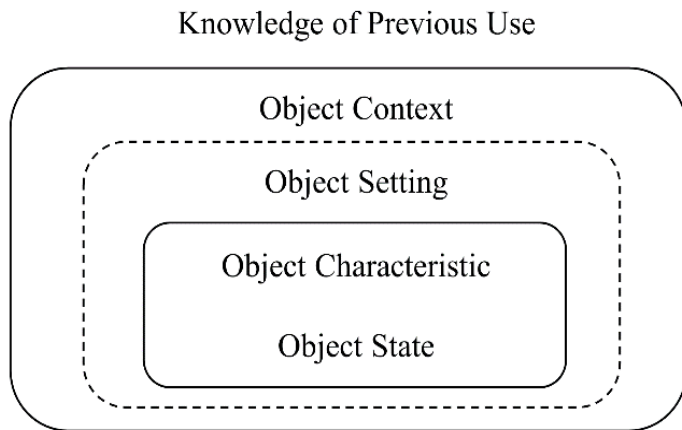


Figure 6-2 Categorical levels of indicators of use

bookmark, highlighted sections and warped pages, and all could be recorded as individual observations. In practice, participants recorded observations for around 30 distinct objects with a few showing multiple indicators. Participants were further encouraged to make the observations across multiple locations (office, home, during travel,

etc.) to cover a varying level of private and public environments. Finally, participants were asked to record images of the observed indicators to support interpretation of the observations.

The procedure for recording the observations involved filling in four columns of the journal with the following information: observation number, location of observation, used object observed, and indicator of use. This procedure was defined after multiple pilot studies using various instructions. Other possible instructions, such as explicitly focusing on the object's material, were found to be leading and produced results that either did not provide context or were confusing to participants. The procedure allowed us to gather adequate information to generate a general typology of indicators and identify common sensorial properties. It also provided enough contextual information to assess if used objects were also perceived as contaminated in the second phase of the research.

Data analysis

At the end of the study all journals were collected and transcribed. Entries were checked for completion and validity and participants were asked necessary follow-up questions. Transcribed results were then anonymized and codified to provide consistent descriptions of places, objects, and indicators. Next, the indicators of use were categorized according to a general typology and evaluated based on sensorial properties. This achieves the first part of the research aim—identifying and categorizing indicators of use.

A total of 710 observations (average 33.8 per participant) were gathered in this study. Observations were deemed invalid if the entry was incomplete or off topic (e.g. recording what they liked about the object rather than an indicator of use). In total, 28 observations were deemed invalid while an additional 8 observations were dependent on some knowledge of previous use and were beyond the scope of the study. These have been removed from the final data set resulting in 674 usable data points. After codification, each observation was labelled as being conducted in a private or public setting to establish if the data set provided good coverage of both contexts. This was confirmed by the observations conducted in a private setting summing up to 32% of the total observations and those in a public setting to 55%. The remaining 13% of the observations occurred with objects that travel with the individual (clothes, bags, phones, etc.) and thus occur in both private and public settings

The data set was initially analysed in two ways. First, codified indicators were grouped through an iterative process to develop the typology presented in Figure 6-2 consisting of five categories: (1) knowledge of previous use, (2) object context, (3) object settings, (4) object characteristics, and (5) object states. These categories provide a comprehensive characterisation of the indicators. The typology ranges in terms of proximity to the object with the outermost category being knowledge of previous use. Knowledge of previous use is the highest-level indicator, and the least reliant on object changes. This emerged in a few observations and has been included for context but it does not appear in further analysis since it is beyond the scope of this study. Object context considers the location and position of the object being considered and any accompanying objects. Object setting, the first level dealing directly with object features, considers reversible configurations of an object. Object characteristic and object state, the innermost indicators of use, directly relate to deviations in expected and perceived sensorial properties of the object with a clear emphasis towards materials and interactions with materials. Indicators grouped as object characteristics and object states represented 80% of the observations and were described by either explicitly stated or otherwise inferred sensorial properties. As expected, descriptions of sensorial properties identified deviations from an expected new condition mostly reflected by changes to material properties.

The data set was subsequently analysed to identify and understand the sensorial properties underlying indicators of use categorised as object characteristics and object states. In many cases, sensorial properties were directly conveyed with comments such as the café table “felt sticky” or a toaster had a “smell from recent use”. The remaining observations were rich enough to infer the relevant sensorial properties of the used object. For example, a stain on clothing would imply a changed colouration, and scratches on a surface may point to smoothness. Participants were contacted for clarification in situations where a sensorial property could not be determined through the description provided in the journal.

Where possible, sensorial properties from an existing list were used (Karana et al., 2009). Consistent with this existing list, *elasticity* and *strength* are technical properties but are used as sensorial properties due to general familiarity to people. Materials also played an important role in the identification of the resulting sensorial properties. Technical material properties determine changes in an object causing an indicator of use but often have nothing to do with the resulting sensorial properties. While *hardness* may cause a scratch to appear on a surface, the resulting sensorial properties have nothing to do with hardness (or softness); rather they reflect *roughness* as the scratch raises the surface, and loss of *colourfulness* as the scratch removes a layer of paint. Thus, knowledge of the technical properties of the materials used to embody an object, coupled with an understanding of the likely interactions with that object over the course of use, produced the sensorial properties described below and their links to contamination.

Results

This section presents the indicators of use and the sensorial properties of used objects identified in this phase of the research.

Indicators of use

The four types of indicators of use in Table 6-1 provide an understanding of what signals that an object has been used. The first three categories directly relate to the object and comprise most recorded observations. The fourth category—object context—differs from the previous ones in that it considers contextual factors such as the location of the object or the presence of accompanying objects. Object characteristic (45%) and object state (35%) categories directly relate to sensorial properties at the level of object features (e.g. materials) and

comprise much of the analysis in the following section. Object setting (4%) and object context (16%) categories do not immediately relate to sensorial properties at a material level and are discussed in this section for reference.

Table 6-1 Categorized indicators of use

Category	Example terms used within category
Object Characteristic	Dents, scratches, cracks, loose, wear, ripped, stained, corroded, sharp/dull
Object State	Clean/dirty, wet/dry, warm/cold, loud/quiet, empty/full (e.g., weight), smell
Object Setting	On/off, opened/closed, set positions, locked/unlocked, lit/unlit
Object Context	Location—where is the object located? Accompanying objects—do other objects imply use?

Object characteristics refer to permanent changes. It appears that this type of indicator is easily identified since it was the best represented category with 45% of the observations. Among the most commonly mentioned characteristics there were stains, scratches, and dents. Respondents described an indicator in terms of the change to an object relative to its perceived or assumed normal state. For example, participants reported that a book spine was loose, implying that a new binding would be stiff. This category also included permanent changes that are natural conditions of use or aging. Circumstantial corrosion or changes in performance, for instance, may be the natural consequences of lapsed time but they show a deviation from a new condition.

Object states are indicators which, with a reasonable degree of effort, could be reverted to an original condition. This category was also well represented with 35% of the observations. As with the previous category, participants discussed the state of the object in relation to what a new object may exhibit. The most common indicator of an object's state was some commentary on its level of cleanliness. The presence of dirt, lime scale, water, smudges or grease implies that something or someone has altered the condition of the object. Similarly, the temporal heat left in gloves or a chair or any number of transient smells indicate recent use. There are conditions in which the object state may lead to changes in object

characteristics. A single cigarette smoked in an automobile may lead to a temporal smell but years of smoking may create a practically irreversible odour. In such cases, the temporal nature of the indicator should be considered for proper classification.

Object settings are non-permanent changes to an object's designed configurations. A particularly informative example occurs when a car contains two key fobs for two separate users (Baxter et al., 2015a). Many modern cars can recall many settings and match those settings to the key fob used. This allows people who share a car to each have their own place. If a driver accidentally uses the other fob, different music settings, seat adjustments, and mirror placements would, for example, be experienced. Other examples of settings included the adjusted height of an office chair, pressed buttons, (un)locked doors, cabinets, lockers, keyboard height adjustment, and faucets left on or off. This category accounted for 4% of the observations.

Object context differs from the other three categories in that considerations extend beyond the target object. In such cases, the object itself might not change but something in the surrounding environment implies use. Two main themes comprise these indicators: location and accompanying objects. Location refers to instances when the object was not expected to be in a location (e.g. a chair in the hallway) or its position had been altered from the last encounter by the participant (e.g. chairs aligned in a circle). In other instances, accompanying objects often implied use of the target object. For example, seeing an opaque milk carton situated next to a cup containing milk made a participant assume that it had been used to pour the milk although there was no sign that the carton had been used. This differs from simply having knowledge of previous use since use can be deduced from the context at hand. Contextual indicators of use represented 16% of the observations.

An example of each of these categories is shown in Figure 6-3. The door handle is an example of knowledge of previous use since no other indicator implies that it has been used. Object settings are shown with a foldable chair configured in a flat position propped up against the wall. Object context is shown with a littered bottle and displaced chair implying that the table has been used. A wet towel represents an object state. Finally, object characteristics are shown with a candy machine that is faded in the sun and has chipped paint.



Figure 6-3. Examples of indicators of use. Images are described clockwise from upper left. Knowledge of previous use: handle with no signs of use. Object setting: chair in collapsed setting. Object context: littered bottle indicating someone had used the table. Object characteristic: outdoor candy machine with faded colour and chipped paint. Object state: towel wet from use.

Sensorial properties and use

Twenty one sensorial properties emerged in this study including eight that were not part of the list upon which this work builds (Karana et al., 2009). The sensorial properties are presented in Table 6-2 grouped by the senses engaged, and matched to technical classifications. This is intended to show the various senses that users engage when observing an object, and how technical designers might begin addressing them. The sensorial and technical properties in Table 6-2 also highlight the overwhelming bias towards tactual and visual senses. This may reflect the amount of information gained through these senses. Finally, Table 6-2 provides two examples of how observations translate to sensorial properties. The objects used in the examples intentionally differ in terms of complexity to

show how any object can be assessed across the sensorial properties. The eight new sensorial properties are now described.

Wetness and *stickiness* are sensorial properties related to the cleanliness of an object. These categories directly relate to the material, rather than contextual factors, in that fundamental material properties impact how well a liquid is absorbed or a substance adheres to a surface. Perhaps more importantly, these two sensorial properties are determined by materials in that they relate to how well the underlying material could be cleaned.

Sharpness is the general term for how sharp (dull) an object is. Knives, edges of paper, and scissors were all commonly reported as being used because they were no longer as sharp as they once were. Other items, such as rented ice skates, were reported as being used since they had recently been sharpened.

Resistance refers to the ease of movement of a component of the object. A new book may initially be stiff and resist opening, while a used book shows reduced resistance to opening.

Separation is simply the discontinuity of an object. Objects may become separated due to a failure of a joining process or through cutting, ripping, or tearing away materials. In some cases, separation was perceived because part of the object was clearly missing (separated) from the rest of it, as it is the case with an unevenly ripped piece of toilet paper.

Loudness is significant because the presence of or changes in noise can indicate use such as the squeal coming from worn brake pads.

Pattern and *flatness* each relate to perceived changes in the surface characteristics of an object. Pattern refers to a change in the original arrangement of the object such as a carpet flattened in varying directions creating a visual pattern. Flatness is the morphing of a surface as seen in water-damaged pages of a book or deep ruts in a road frequented by heavy vehicles.

Clearly, the sensorial properties emerging from using an object and altering it from its state of new are highly dependent on the material properties. Ductility and elasticity depend on the modulus of a material, warmth depends on the ability of an object to retain (discharge) heat, and so forth. This provides appropriate directions for designers who can evaluate

material options and other object features as a means of eliminating indicators of use due to interactions. It also allows design decisions to go beyond 'avoiding wear and tear' to intentionally identify the cause of the indicator of use and compensate appropriately.

Table 6-2 Summary of sensorial properties, related technical classification, and examples of indicators of use^a

Sensorial Property		Technical Classification ^b	Example: Car	Example: Book
Visual	Colour Intensity (intense-mild)	Optical		Faded cover due to UV radiation
	Colourfulness (colourless)	Optical	Stain on the seat	Pen markings and coffee stains
	Transparency (opacity)	Optical	Scratches on window	
	Glossiness (matte)	Optical	Steering wheel made matte where hands go	Edges of book are matte from rubbing
	Reflectiveness (not reflective)	Optical	Water stains on mirror	
	Pattern (uniformity) ^c	Optical	Fabric flattened at feet	
	Flatness (unevenness) ^c	Manufacturing		Warped pages due to water damage
	Separation (completeness) ^c	Mechanical		Cover of the book is ripped
Tactual	Softness (hardness) ^d	Mechanical	Seat cushion hardened due to use	
	Weight (heavy-light)	Atomic		
	Ductility (ductile-tough)	Mechanical		Corners are deformed
	Strength (low- high) ^d	Mechanical	Windshield is chipped	
	Elasticity (low- high) ^d	Mechanical		
	Smoothness (roughness)	Mechanical	Fabric of seat changes in smoothness	
	Warmth (warm- cold)	Thermal		
	Sharpness (sharp- dull) ^c	Manufacturing		Paper edges have dulled over time
	Stickiness (not sticky) ^c	Chemical	Cup holder has a sticky residue in it	
	Wetness (dry) ^c	Chemical		
	Resistance (compliance) ^c	Manufacturing		Book binding has become looser over time
	Olfactory	Odorous (odourless- fragrant)	Chemical	Traces of cigarette smoke
Auditory	Loudness (quietness) ^c	Acoustic	Squealing when braking	

^a The examples chosen in this table are used to demonstrate the relationship between indicators of use, sensorial properties and technical material properties. The indicators of use under each example are compiled from a number of observations to provide exaggerated examples.

^b The technical classification aims to link sensorial properties to technical material property categories. This additional information provides potential cues for design enhancement.

^c Indicates sensorial properties not included in a previous sensorial list used by (Karana et al., 2009).

^d Indicates that several sensorial properties adopted from (Karana et al., 2009) also have technical definitions. These terms are maintained due to the use of the term by the lay person but the inconsistency is noted as a potentially problematic area of communication between designers and users.

Linking indicators of use to contaminated interaction

The previous section determined a general typology for indicators of use and their associated sensorial properties. These results are now substantiated in the context of contamination through a secondary analysis of the observations. This second phase of the research isolates those indicators of use that would contribute to contamination. The result is captured in the HUT contamination model shown in the remainder of this section. Where the first phase of research identified indicators leading to the perception that an object has been used, this phase accomplishes the second part of the aim, which is to link indicators of use to contamination. Together the two phases of this study show how the technical features of an object (materials, joining processes, geometry, etc.) and the interactions between an object and its users produce indicators of use, and how these indicators subsequently result in contaminated interaction.

Method

This section details the method employed to link indicators of use to contaminated interaction.

Participants

Following the first phase of research, informal interviews showed that participants could easily identify if they had an aversion to objects but they had much more difficulty articulating why. Hence, to gain useful insights it was judged critical to collect additional qualitative data. This was achieved by recruiting two participants who were also involved in the previous phase of research to create an informed evaluation of the observations.

Procedure

Using the complete data set collected during the first phase of the research, the participants were asked to independently create a subset of the indicators of use contributing to contamination—described to them as interaction that arouses feelings of aversion. Observations contributing to contamination were marked by the participants on a binary scale (does or does not cause aversion) rather than establishing a degree of contamination. The rationale for this is that the degree of contamination differs according to the person involved, the context and the object at hand, and therefore it is easier to establish trends rather than absolutes. In this part of the research it was essential that participants can empathically interpret the observations recorded by others to form a perceived interaction. This involved

understanding the sensorial mode (touching, seeing, smelling, etc.) and context (public space, private residence, etc.) behind the observations. For example, a person may have no problem seeing a wet towel that belongs to someone else but touching one may well become a problem. Similarly, touching your wet towel at your home is different from touching a wet towel used by another person in a gym. To a large extent, the mode and context of an interaction was described through the participant's location, the observed object, and the indicator of use reported in the previous study. Still, this information could be understood differently so after the task each of the two participants was interviewed extensively about the results. The responses from participants were then analysed to determine trends.

Data analysis

The two participants identified a total of 548 observations contributing to contamination. Agreement between the participants regarding which observations contribute to contamination and which do not was relatively weak (correl. 0.58). Discrepancies were generally the result of imagined interaction that went beyond the data provided. For instance, one participant noted aversion for fingerprints on a screen, while the other did not. When questioned, the participants explained that they had imagined different sources for the greasy fingerprints, and through explanation and reasoning both tended to agree.

Observations contributing to contamination were grouped according to underlying patterns. For these patterns, effort was made to understand the fundamental mechanisms driving aversion through interviews with the participants. Three mechanisms driving contamination emerged: hygienic contamination, utility contamination, and territorial contamination. Together these mechanisms form the HUT contamination model. The mechanisms are not mutually exclusive. Examining the frequency with which an observed indicator contributed to one or multiple mechanisms of contamination informs the nature of interaction amongst the various contamination drivers. This analysis is visualised in Figure 6-4 using the eulerAPE software (Micallef and Rodgers, 2014).

The result of this study is a three-part breakdown of how frequently the five indicators of use and the 21 sensorial properties contribute to each of the mechanisms driving contamination. Studying the relationship between contamination and the sensorial properties associated to the indicators of use, any observation based on knowledge of previous use, object context and object setting was excluded. As discussed in the previous study, a single indicator of use may contribute to

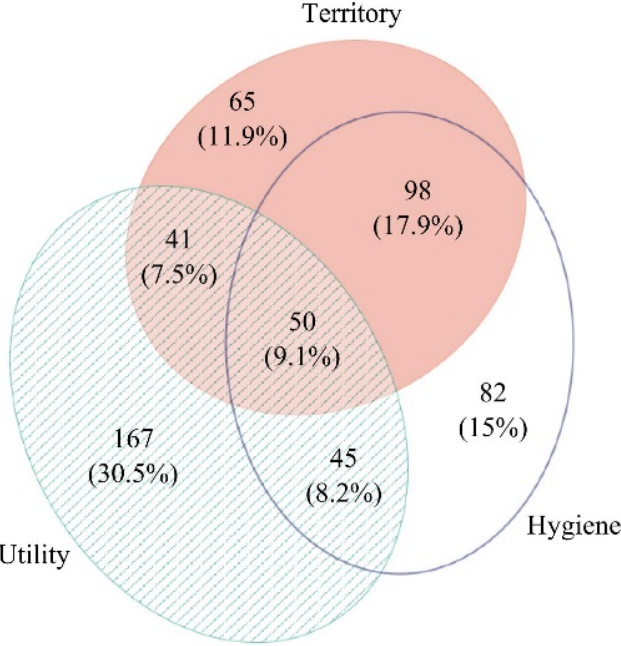


Figure 6-4 Frequency of HUT drivers of contamination occurring alone or together across indicators of use.

multiple sensorial properties, e.g. a scratch may contribute to smoothness and colourfulness. This resulted in a total of 557 instances in which a sensorial property contributes to contamination. Table 6-3 summarizes the number of instances per sensorial property.

It is also important to mention that that the highly contextual nature of contamination has made it challenging to precisely compute the strength between a given sensorial property and the resulting contamination. A scenario can emerge in which nearly any sensorial property contributes to a mechanism of contamination but this study makes no attempt at finding these absolute relations. Rather, employing a quantitative assessment of the qualitative analysis, this study aims at generating trends from the data to gain useful insights as presented in the next section.

Table 6-3 Number of instances contaminated interaction corresponded to a given sensorial property

Sensorial Property	Number of instances
Colour Intensity	48
Colourfulness	130
Transparency	28
Glossiness	21
Reflectiveness	34
Pattern	13
Flatness	23
Separation	45
Softness	5
Weight	8
Ductility	19
Strength	18
Elasticity	9
Smoothness	38
Warmth	11
Sharpness	8
Stickiness	12
Wetness	33
Resistance	8
Odorous	35
Loudness	11
Total	557

Results

This section presents the three identified mechanisms driving contamination: hygiene, utility, and territory. Together, these comprise the HUT drivers of contamination. Hygiene contamination occurs when indicators of use are perceived to pose a threat to one's health. Utility contamination occurs when indicators of use show a decrease in perceived value or functionality. Territorial contamination is the result of an object perceived as being marked, i.e. belonging to someone else.

The categories of contamination were found to have a degree of overlap. Consider the simple example of a plastic pen with a lid that has been chewed. It is likely that a person exposed to

such a pen that has been chewed by someone else may feel aversion toward using it. When asked about the pen, the same person may explain that the teeth marks have created sharp edges making it unpleasant to hold or touch and that the chewing has warped the cap such that it falls off easily. These are examples of utility contamination as the pen has lost some of its functionality. The person may also explain how the teeth marks signal that the pen belongs to someone else and that because it has been chewed it is not sanitary. These are examples of territory contamination and hygienic contamination, respectively. The interplay between these mechanisms is shown in Figure 6-4. Notably, all three types of contamination occurred simultaneously in 9.1% of contamination cases. Utility had the largest individual occurrence of contamination at 30.5%. Hygiene and territory are the drivers that most commonly occurred together accounting for 17.9% of contaminated observations.

Hygienic contamination is marked with communicable object states and object characteristics as well as knowledge of previous use, object settings and object context. This type of contamination occurs when indicators of use resemble a hazard to health. Object states, for example, are often able to transfer, in a literal sense, their properties such as moisture, sticky residue, smells, and grease. Sensorial properties related to hygiene and object states, as seen in Figure 6-5, include wetness, stickiness, odorous, transparency, glossiness, and reflectiveness. Object characteristics mainly contribute within this category in terms of permanent changes in colour. Changes in colour intensity or colourfulness, most often due to stains, indicated that the object was at one time contaminated and participants questioned if the material had been properly cleaned. Finally, knowledge of previous use, object settings and object context all contributed heavily to hygiene. A common sentiment from participants is that the condition of the object reflects likely cleaning behaviour of the previous user. Thus, messy or damaged objects were thought to be less hygienic since participants assumed that they were poorly cared for.

Utility contamination is most often marked with permanent changes to object characteristics. It occurs when an object is perceived to have a decreased ability to fulfil its functions. Functions can be technical, aesthetic, social, economic and latent (Aurisicchio et al., 2011; Childs, 2013). Some of the most prominent properties relating to these changes are

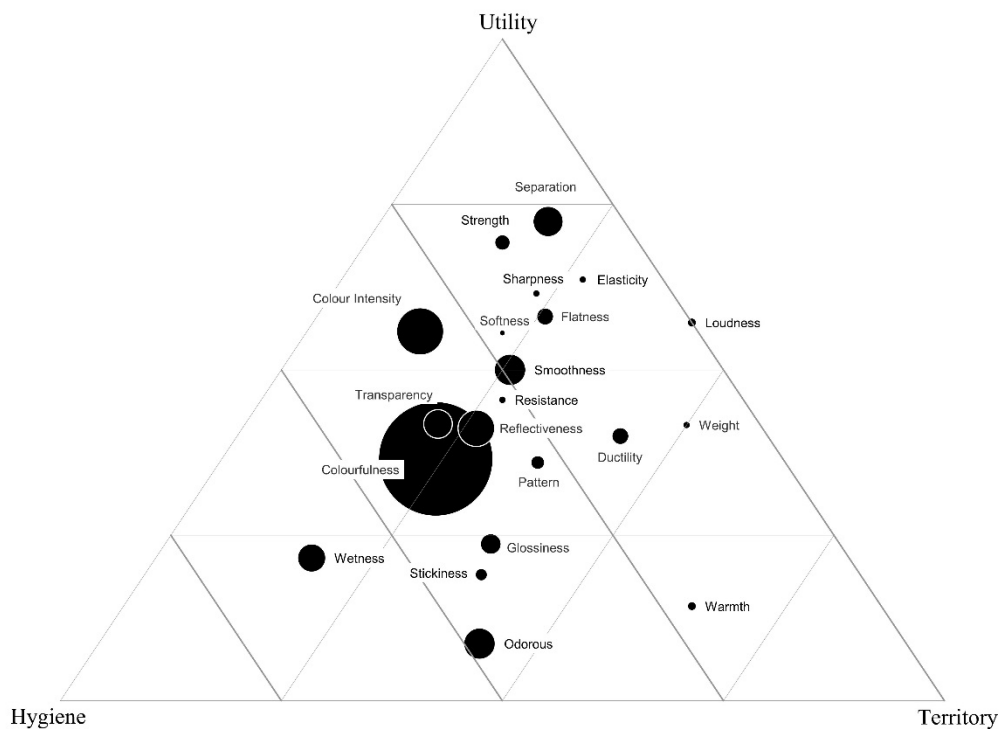


Figure 6-5 HUT contamination triangle. Location of a sensorial property is determined by the frequency with which the property contributed to each of the three contamination mechanisms. Size of a sensorial property is determined by its overall occurrence relative to the others.

separation, reflectiveness, flatness, strength, colour intensity, colourfulness, smoothness, and transparency (see Figure 6-5). These properties are not surprising since they are the consequences of normal wear and tear, and subsequent negative appraisals of objects.

Territorial contamination is primarily marked with revertible changes to object settings and the context around an object. Settings are often chosen by a user in an intentional attempt to personalize the object and contextual factors mainly refer to accompanying objects, e.g. a photo on a desk is an indicator that the desk is being used. It is, however, important to note that object characteristics and object states also contribute to territorial contamination often leaving a personal mark in some way. Figure 6-5 shows that some of the most prominent properties relating to transient object states, object characteristics, object settings and contextual factors are warmth, odour, glossiness, stickiness, ductility, reflectiveness and smoothness. Bite marks on the end of a pencil (smoothness), for example, indicate that the object has been used by another person and leaves a claim on the object as theirs. Patterns

generated (or destroyed) from repeated use such as numbers worn off on keyboard keys seemed to give a narrative of how someone uses the object. Transient properties may be more salient cues of territory concerns because they have a lifespan, i.e. the object has been touched recently enough that the property has not subsided or been cleaned. Examples include the odour of a loved one's perfume on a shirt, body heat leaving a chair warm, sticky residue on a handle, or finger grease making a surface glossy.

This study completes the link between the sensorial properties of use and subsequent contaminated interaction. Consider, for instance, the role of the sensorial properties of materials in the HUT contamination triangle of Figure 6-5. A designer might select a material for a product that, through subsequent interactions, results in a change in colourfulness. Such a change is likely to impact all three drivers of contamination. Similarly, an object that is likely to show some form of separation will mainly contribute to utility contamination. Finally, materials that create or retain a foul odour are likely to contribute to hygienic and territorial contamination. The rest of the properties could be considered in a similar fashion to understand how early design decisions can mitigate contaminated interaction. As stated previously, these trends should be taken in context since any given sensorial property could contribute to one or multiple drivers of contamination.

Study 5 Discussion

Karana et al. concluded that the meaning attributed to a material depends on: (a) the type of material, (b) the product in which the material is embodied, (c) how the product is used, and (d) the background of the user (Karana et al., 2009). This study expands that work by proposing that the meaning attributed to a material is determined by the condition of the material used to embody a product. Meaning derived from indicators of use can help people assess the degree to which used objects are hygienic, offer utility, and are perceived as one's own property.

Studying the perception of use and contamination has helped understand how design decisions (material selection, joining processes, etc.) are linked to contaminated interaction. Object characteristics (permanent indicators) determining utility contamination may be best accounted for through traditional design for durability such as the rate of surface wear,

material strength, and joining processes. Territorial and hygienic contaminations are less intuitive and are certainly less accounted for in current design practice. Territorial contamination is mitigated by erasing signs of previous users. This requires introducing design defaults for object settings and contextual factors. Careful consideration should be given to understanding the object characteristics and object states that inform about previous users and these should, where possible, be eliminated. Finally, hygienic contamination largely results from transient properties. These require stronger consideration of the role of services or maintenance in preserving the condition of the object. In these cases, materials could be selected that are more easily cleaned and maintained. The prevalence of hygienic contamination in the results suggests that transient conditions show more salient indicators of use and should be a priority in design.

Design strategies should also consider the application and use of the object. Objects used for a long time by one individual exhibit vastly different conditions than those of shared objects. When owning an object, hygiene is a minimal concern because the object—and any cleanliness issues—belong to the person. Territory is reinforced by materials that change over time and create a positive narrative in the patina. Utility is also viewed differently since it is likely that the individual takes better care of the object and can preserve the quality of the object to the standard that is deemed fit. This contrasts with situations where objects are used briefly and between users as readily seen in workplaces, restaurants, transport and other public spaces. In such situations, any sign of previous use can readily give rise to all forms of contaminated interaction. Designers should carefully consider how they might mitigate or control changes over time given the context of the object.

Engineering design capacity to confront contamination needs to be developed across all areas. Utility contamination benefits from significant engineering work in durability and the designer's ability to easily perceive and communicate durability concerns the way in which a user does. The mitigation of utility contamination is simplified by the fact that objects can be easily analysed in a laboratory setting and the user is often not needed. The more nuanced areas of hygiene and territory contamination require more attention since the cues can be subtle and the consequences drastic. In these situations, the object is often avoided

completely since it is either perceived as belonging to someone else or as unclean. These forms of contamination also require design research that involves examining objects in use and observing and talking with users—a method still unfortunately uncommon among many designers.

This study is primarily limited by the breadth of observations collected, an ability to infer sensorial properties, and participants' ability to imagine interactions with used objects. Because of this there are likely to be additional sensorial properties not included here which contribute to contamination. Sensorial properties relating to taste, for example, are not included in the data set though it is easy to imagine the presence and usefulness of such properties in the context of food design. Future studies might explore this and other sensorial properties relating to used objects as a way of building on the present work. Future studies may also aim to expand materials maps to reflect technical parameters that map to sensorial properties and subsequent contamination.

6.5. Study 6: developing a general framework for contaminated interaction

The last study investigated indicators of use, associated sensorial properties and themes around which people form an aversion to used things. In Study 6, a contextual understanding of contaminated interaction as it relates to design is presented. The aim with this study is to situate contamination as a broader design construct so the design community can be better equipped to successfully identify and address it. This study adopts a method of combined literature review and primary data collection regarding instances in which someone else's previous interaction with something enhanced or diminished the individual's interaction (interpersonal contamination). The three types of contamination identified in Study 5 (hygiene contamination, utility contamination and territory contamination) are further validated and elaborated upon. Findings are further summarised to develop an ontological model describing contaminated interaction.

Methods

This study enhances the understanding of contaminated interaction through an iterative process of analysing existing literature and gathering accounts of user experiences involving contaminated interactions. The latter consisted of two parts. In a preliminary study, 41

participants listed items they felt were contaminated due to some prior use. The intent of this exercise was to gauge the range of products listed as well as the ease at which items were identified. Results from this pilot study indicated that more direction was needed to better understand the phenomenon including the surrounding context of the interaction and the reason it had been tainted in some way. Accordingly, in the second phase of the study, interviews with ten participants were conducted to provide a deeper understanding of a range of interactions they felt were positively or negatively enhanced due to someone previously using the object.

The approach taken in the interviews was semi-structured in the sense that the topic, initial questions and question sequence were predetermined. Interviews diverted in their exploration of the specifics around each explored interaction. Participants were briefed a few days before the interview to allow time to think about possible objects they might discuss. The interview consisted of asking for an object enhanced (diminished) due to some prior use. Next, participants were asked questions regarding how it was used previously and what contributed to enhanced (diminished) value. Specific attention was given to inquiring about both physical and digital objects ranging from products to environments. Results from both phases of the study were regularly compared to relevant literature to identify trends and themes. Of particular interest here was an understanding of the key constituent parts of the interaction in order to develop a model for understanding.

The age of participants varied from 21 to 70 years old and was evenly split between men and women. Educational backgrounds varied significantly from those who have not finished high school to individuals with PhDs. Occupations also were varied. Included in the survey was a student, a management consultant, an entrepreneur, a medical doctor and a designer amongst others. The interviews, including the initial prompt, typically lasted between 30 and 45 minutes. Audio recordings and notes were made for each interview. Following each interview, the audio recording was transcribed and analysed for recurring themes such as reasons for contamination occurring and contextual elements of the interaction at hand.

Interviews and literature were analysed together in an iterative process. Attention was given to identify the types of objects used, the scenarios through which the objects were engaged

and the underlying reasoning behind why the experience with the object was perceived to be better or worse.

In what follows, the combined insights from literature and the collection of primary data are presented.

Contaminated interaction in context

Building on previous work (Baxter et al., 2016a), literature and primary data on contamination is reduced to three categories relating to health (Abbey et al., 2015a, 2015b; Greed, 2003; Muro and Noseworthy, 2013, 2013; Nemeroff and Rozin, 1994; Rozin et al., 2015; White et al., 2016), interpersonal space (Alias et al., 2014; Argo et al., 2006, 2008; Bardhi and Eckhardt, 2012; Belk, 1988a; Goffman, 2009; Griffiths and Gilly, 2012; Hood, 2009; Kim and de Dear, 2013; Luck and Benkenstein, 2015; Newman et al., 2011; Newman and Bloom, 2014; Smith et al., 2015), and functional value (Abbey et al., 2015a, 2015b; Andrews, 2015; Liu et al., 2009; van Weelden et al., 2016). These are termed hygiene, utility and territory, respectively. Together these determine the value changes needed to moderate a contaminant as positive or negative.

As mentioned in the prior study, these drivers are not mutually exclusive, and in many cases, it seems most correct to examine the contamination from two or three drivers. The drivers also vary in the extent to which they can be considered dynamic or static interactions. Dynamic interactions often occurred within environments. In environments, the contaminant is often transient: fleeting smells, other people, noises, etc. For products, the contaminant was most often static as the contamination occurred but was not ongoing.

Results showed a wide range of physical and digital products and environments. Physical products included clothes, books, guitars, jewellery, furniture, and instruments among others. Physical environments included a car, public transportation, work environment, restaurants and schools. Digital products included webpages, mobile phones, television, and other consumer electronics. Digital spaces included social media, personal website accounts (i.e. Netflix), and online forums.

In a negative context, contamination was found to lead to consumers misusing, negatively experiencing, or avoiding the object altogether. Positive contamination sees the opposite effect in which usability can increase, users report more positive experiences and users seek out or cherish the object. A summary of results from the three drivers is shown below.

Hygiene

Hygiene considerations respond to feelings of disgust. Disgust is thought to be an evolved revulsion to pathogens (Curtis et al., 2011; Curtis, 2013). This was highlighted in participant responses through the adjectives used when describing contaminated objects: clean, sick, sanitary, gross, sweaty, contagious, smelly, and dirty. It also follows that more familiar sources of contamination (i.e. germs from a loved one) are reported as being less severe than less familiar contaminants (germs from a stranger) (Nemeroff, 1995). Similarly, feelings of contamination will increase if the object is more intimately used and subsequently has a higher chance of carrying and transferring a harmful substance (Abbey et al., 2015b, 2015a; O'Reilly et al., 1984). The nature of hygiene is such that it is always seen with physical artifacts and nearly always moves from positive to negative.

Positive Hygiene

In the present study, no instances of positive hygienic contamination were identified. This is not surprising since this would require that an object go from dirty to clean and this rarely happens due to prior use. This is, however, a theoretical possibility and one can imagine situations in which positive hygienic contamination occurs. For instance, a roommate may clean the house to use it for a specific purpose and in the process, return it from its dirty state to a clean one.

Negative Hygiene

Examples of negative hygiene were very prevalent. In the pilot test, participants talked about spoons, keyboards, restrooms (door handles, toilet handles, toilet seat), and public transportation that all elicited feelings of disgust. P23 recorded their experience as follows, "The seat had lots of droplets on it. It was hard to tell if it was water from the flush or urine, but it really put me off using it! I had to wipe the seat with toilet roll before I could use it and

even then, it felt gross!" The disgust was also for non-bodily fluid such as pesticide still on the outside of an apple and no way to wash it (P19).

Other participants described how they felt disgusting substances contaminated their objects even if there was no contact, "I once ran into a drunk who ended up spitting on me and I had just bought a set of books and the back of my books were close to the saliva and I wanted to return the books even though there was no actual contact" (P28).

Others projected a vivid narrative for which they had no actual perceived experience. P17 records it as follows, "Many people have touched this door handle and they might have not washed their hands after going to the bathroom. I wanted to use tissue to open the door but someone was in the toilet stall that had the tissue in it so I had to open the door with my bare hands. I was not happy." In a similar sentiment, P31 expressed the uncomfortable perception of sharing a work phone, "Now I have to share my office phone with three other people. The idea of other people handling it but moreover breathing on the handset and making it smell grosses me out." P35 described her thoughts about magazines in the waiting room at the doctors, "Magazines in reception at the doctors have been read by other people. Who knows how ill they were or what they had! All kinds of viruses and germs on the pages—it makes it feel dirty. But I'm going to be waiting a while and really need to read something. I'll read it, but feel grubby fingers and exposed to illness." When referring to moving into a new flat, P9 noted, "Moved into a flat with an existing mattress in the bedroom. It wasn't necessarily contaminated, but felt that way." The narrative existed even if the source had been completely recycled. P22 expressed her aversion to recycled toilet paper, "You don't know about the previous use of the paper—its origin. This thought always keeps me away and I avoid purchasing it."

The extended interviews revealed sentiment in the context of caring for and comparing to others. P44, a mother of two young children, related her frustration of using public changing tables when her children have a dirty diaper. "I went to use it and it was like really gross. There was poo on it. Someone hadn't cleaned it up. It was really crusty and gross. Well I needed to use it I didn't have another option. So, I covered it with a million paper towels. [...] And just

because I'm now freaked out that there is gross stuff on there, I carry with me now just disposable pads to lay down-like changing pads."

In comparison to others, P42 explained how her friends give her a hard time for second-hand purchases, "I've had that before where I've bought something like a vase or something, and they were like 'Oh did you clean that? Did you wash that yet? You better get the Lysol out.' And I'm like 'it's a vase. I'm not scared of a vase.' So, I mean they'll think it's cool but they won't want it themselves."

Technology is often used to prevent negative influences of hygiene from occurring. In a public restroom, it is increasingly common to have automated toilet flushing, fragrance emission, faucets, and hand dryers. Some toilets even have automated seat cleaners. Each of these technologies is driven to a large extent with the aim of preventing negative contamination.

Utility

Utility considerations concern an assessment of the functional value of an object. Functional value includes technical function but also social, aesthetic, or economic needs of the user (Aurisicchio et al., 2011). It follows that those features associated with functional value are closely tied to contamination. Adjectives used when describing utility include: faster, better damaged, worn, cheap, broken, and ruined. Changes to an object that deal more closely with the functional value of an object are expected to have higher impact on contamination. This category is the broadest in scope and the most obvious in terms of where current design has been implemented, e.g. design for durability.

Positive Utility

In the context of interpersonal contamination, positive utility is about enhancing the functional aspects of a product. In the simplest form, this is a return on investment of time, money and energy on the part of the user. Unsurprisingly then, several respondents talked about how previously used things were better since the upfront investment (e.g. cost) was lowered. P44 explained simply, "Well I bought a blender second-hand, so it was better in the fact that I didn't have to pay \$400, and it works great." Similarly, P50 spoke of some pots and pans gifted to her when some friends moved and no longer needed them, "I love to get high quality products that are inexpensive or free. These pots and pans are really good quality and

I feel they are better because they are cheap—well free—and it is better for the environment to get them second-hand.”

Saving time was another theme in this section. P52 explained how he could not be bothered with setting up electronics so he would often get people in to help him. He would frequently seek help when upgrading his phone or setting up a new TV. For him, the benefit was that someone else was doing the initial setup.

Finally, saving effort was found through experiences in which an item was improved after it was loaned to a friend. P42 describes how lending her laptop computer resulted in a more positive experience, “I’m not a computer person really and I don’t know about virus protection or other types of things that are about the item, and he has so much knowledge about it, that when he borrowed it I asked him to look through it and tell me if I needed better virus protection etc., and he returned it in definitely better condition than it originally was in. [...] I appreciate the computer more because I feel like it goes faster and I have more control of the object itself because I feel like it’s more mine because I understand it better.”

Participants reflected on how they avoid new items to not front the higher levels of risk associated with potential manufacturing or building errors. P51 noted his preference for cars or houses that are a couple years old, “Sometimes a car is better if it is second hand because you don’t have all those issues. The reason they say a new car loses its value when it is driven off the lot is mainly because if someone is trying to sell their car immediately afterwards there is probably something wrong with it. [...] I think the same goes with houses. New built houses have a lot of issues right after they are built whereas if you buy it a couple years later, it is still new but it does not have those potential issues that could be disastrous. A friend of mine bought a new build and had to move out a year later because the foundation sunk and there was a huge crack in the wall that essentially made it uninhabitable.”

In another example, P50 spoke of the social value she gained from her desk location at work. She sat in a place that allowed her to overhear much of what was going on in the company and constantly stay in the inner social circles of the company.

Negative Utility

As the functional value of a product diminishes it is referred to as negative utility. Many of these are simple and relatable examples. For instance, P3 notes a phone she got from work that was “scratched so much that the camera was useless.” P15 notes that when he inherited his dad’s old computer, it was “filled with his old junk” and not usable. P16 wrote about a coffee cup that when full, became “soggy” and was difficult to use for drinking.

P42 gave an account of how her boots were ruined when she loaned them to a friend. “So, I have a pair of hiking boots that I really love. They are really high quality and a great brand and I use them quite a bit. My friend was going on a trip and she doesn’t have sturdy shoes and she said, ‘I don’t know what to do I have to leave this weekend and I don’t have money to go buy really expensive nice boots.’ So, I said ‘We are the same shoe size, you can use mine.’ So, she used mine. And I was expecting that, who knows what could happen on that trip, right? So, I did have some like emotional preparation for something to go wrong. But when she brought them back, I guess they had gotten wet, and then she had jammed them into a bag, and basically when I put them on my foot they did not fit in the same way. There was a sharp edge to it so basically they had been battered by her using them.”

P50 had several negative interactions with digital technology. An external hard drive she had purchased second-hand she later found out was not saving her documents. She also talked about how she interacts with social media. Part of the social value she gets from social media is being first to post something, “when others post the same thing I was going to or post a comment without giving me credit it really bothers me. I just move on because at that point it is not worth posting.”

P52 had overall aversion to used items. Interestingly in his case, his wife has no problem with second-hand things but he avoids them to the point it influences his disposal decisions, “She thinks that is a negative aspect of my personality but she does not have a problem. To some extent it has an impact on me when I am getting rid of stuff. I will put something out to the trash and she will say, ‘well why don’t we try to sell that on eBay?’ so it even affects me wanting to offer things second-hand.”

Territory

Territory considerations respond to assessing desired personal space. Included in this are physical elements such as smells, noise, and markings (Goffman, 2009) as well as non-physical elements such as valuing something because it has been touched by someone (Belk, 1988a). Territory includes products and environments that evoke feelings of comfort in one's personal space and relates to sentimental objects.

Positive Territory

P43 spoke much about territorial issues. One strong positive interaction emerges from a scarf she received from her mother. "She has a scarf that she bought when she was twenty and she kept it for ages. I used to see her with her scarf and I used to love her scarf and I'd twirl her scarf. Now she lives in the islands, and she doesn't need it anymore so I took it and I, yeah, just keep it. And it's like old, and you know, it's really imperfect for everything that I have. But it reminds me of when I used to see my mom wearing it [and that] it belongs to her. If it were just a scarf in the shop I'm not sure I'd buy it. The fabric isn't nice but the fact that my mum used to wear it, so when I wear it, it just makes me think of her."

Similar sentiments about meaningful items were shared by several participants. P50 spoke of a blanket made by a family member that made her think of family as well as sheet music that was once owned by a famous musician and the author of the music. P42 spoke of a guitar given to her by a close friend that she cherished because of the memories attached to it, not the objective quality which was not very good. P51 gave an account of a ring owned by his grandfather who he never had the chance to know. The ring acted as a link to feel closer to him.

Environments were also discussed in the context of territory. P45, discussed considerations regarding where to spend time: "for my wife especially, it is important who else goes to the restaurants that we go to. She really likes to go to the places where celebrities also frequent because in a way, we are sharing the same space." The same was true of choosing schools for his children, "it is almost as important who else goes to the school with my children because we share that with other families."

P50 spoke of the territorial nature of social media. In her conception, social media is valuable because it is shared. “Everyone is on there. That is what makes it so much more valuable to me.”

Negative Territory

As is the case with positive territory, negative territory concerns can emerge from strong narratives. P44 shows this with relation to a sewing machine gifted to her by someone with whom she has since had a falling out, “I absolutely want to replace it because of the memory. I want it to be mine—I want the projects to feel like they are mine and not connected to lessons or things she'd given me.”

Often the narratives are built over a long time and can become significant sources of comfort for occasions. In one such instance, P51 described a suit coat he would wear on nice occasions that he had loaned to a friend for a job interview. His account shows the fragility to narratives contained in products: “[My friend] ended up going to the pub with [my suit coat] after [his interview] and I literally said, ‘just keep it.’ This is back in the day with smoking in the pubs and all of that and I just didn’t feel it was a smart coat anymore. He spilt beer on it and all of that. It just didn’t have that special coat feel anymore since he did not look after it.” Though this account is like the example of the boots in 3.2.2, it differs in that the boots were physically changed and impacted their functional value while this coat was cleaned and had no noticeable differences but had a different “feel” that the owner no longer wanted.

Territory is also about environments. To complement and contrast the positive examples of territory in environments given previously, P45 noted that he and his wife are conscious of people who frequent restaurants with whom they do not associate. Similarly, P50 spoke of an incident on Facebook where a former boyfriend kept popping up and she had to block him.

P43 spoke of territorial examples in the context of public transport. Her sensitivity to smell means that she often starts feeling sick if she is around a strong, unpleasant smell. “The person in the bus was in front of me, and she had the strangest smell and odour, and it was like ‘Oh my God!’ It was awful. And like, I just said to my roommate and I needed to move.”

Model

This investigation resulted in an ontological model of contaminated interaction to describe the phenomenon. The idea of the model is that a **contaminator** creates a **contaminant** with a given **status** that changes user **evaluation** of an object resulting in a **contaminated interaction**, see Figure 6-6. The model was developed in an iterative process relying on insight from the literature review and the interviews conducted for this study. Importantly, the model refers to a specific user-object interaction. Thus, prerequisite to using the model, the user and the target object must be identified. This is meant to be a generic model for which the target object may be a product, environment or any other interactive entity.

Contaminator

The contaminator is the person or thing that creates the contaminant. The contaminant can originate from the user, other users, the object or other objects. When coming from the user it is a form of self-contamination in that the user taints her or his own subsequent interactions. A simple but clear example of this is seen in recycling behaviour. When common recyclable characteristics such as form or size become altered—by the user or otherwise—recyclables tend to be subconsciously categorized as waste rather than recycling (Baxter et al., 2016b). The result is that recycling rates can drop to less than one half of the original rates (Trudel et al., 2016b; Trudel and Argo, 2013).

When others are responsible for the contamination, it is referred to as interpersonal contamination. Goffman identifies six types of interpersonal contamination: (1) violation of personal space, (2) touching or bodily contact, (3) glancing, looking and staring, (4) noise pollution, (5) talking to or addressing, and (6) bodily excreta (fluids, odour, body heat, markings left by the body) (Goffman, 2009). Though these are discussed in terms of the

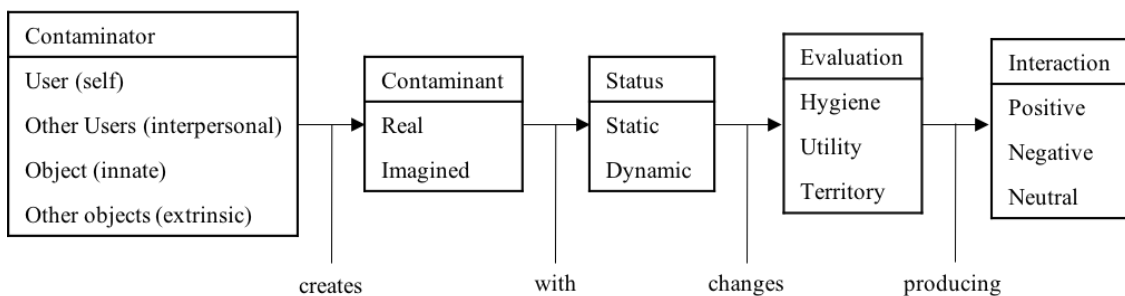


Figure 6-6 The ontological model of contaminated interaction.

physical world, they are either applicable or have equivalents in the digital world. Russell Belk has indicated another form of interpersonal contamination in which an object intimately associated with another person is contaminated by that person (Belk, 1988a).

If the object itself acts as the source of the contaminant it is called innate contamination. For instance, the natural degradation of things (e.g. food) leads to changes in their own properties, which can alter how people interact with them.

Finally, other objects produce extrinsic contamination. Object here is understood broadly to include products but also other entities such as non-human animals. Extrinsic contamination is likely to happen when objects are placed in proximity to others. In some cases, objects in proximity with others may be seen to transfer their properties and subsequently contaminate it (Hou et al., 2015; Morales and Fitzsimons, 2007). In other situations, the presence of additional objects in a user's view may taint how they would otherwise interact. An unsavoury advertisement on a webpage may lead the user to move along more quickly. Another example is how additional objects on supermarket shelves lead customers to buy less and feel less satisfied with their purchases (Iyengar and Lepper, 2000).

Contaminant

The contaminant is that which alters the meaning of the target object. It is identified through information foraged through sensory, environmental, and cooperative means (Argo et al., 2006; Baxter et al., 2016a; Pirolli, 2007, 2009, Pirolli and Card, 1995, 1999). This was explored in detail in the previous study with regards to perceiving use.

Contaminants can be real or imagined. Real contaminants can be objectively examined and are, in some way, perceptible. This includes the physical presence of a contaminant or an alteration to the object's properties. The presence of a contaminant might be a noise or smell for a physical object or it could be an advertisement or comment from another user in a digital context. Altered properties may relate to the colour, smoothness, and other indicators of use for physical objects. For digital objects this may be changes to digital indicators of use, such as likes, upvotes, and reviews.

Imagined contaminants are common. The only indication that something has been contaminated might be the information it carries with it. For instance, land often carries a

stigma regarding criminal activity, murder, disease, and ghosts that are not identified through any perceptible means (Reilly, 2000). The same is true of the changed value placed on recycled water (Rozin et al., 2015), products used by celebrities (Hood, 2009; Newman et al., 2011; Newman and Bloom, 2014), items touched by attractive others (Argo et al., 2008), and possessions of criminals (Hood, 2009). These cases seem to operate according to the related laws of sympathetic magic and the law of contagion which posit that a source magically transfers its properties to a target through proximity and touch and that the source will continue to influence the target even after it is removed (Mauss, 1972; Nemeroff and Rozin, 1994; Rozin et al., 1986; Rozin and Nemeroff, 1990). This is seen in several studies in which the contaminated object goes through a purification process but users still claim it is affected (Hejmadi et al., 2004; Rozin et al., 2015). Treating a contaminant of this type can be particularly difficult (Hood, 2016) and information management should become an important consideration.

Status

The status refers to the process state of contamination. There are two options for this. A static condition means that the object has been contaminated but the process of contaminating is now over. In the baseball example in the introduction, for instance, an alteration to the ball is considered a static situation since the ball is later evaluated as contaminated. A digital equivalent might be an unwanted comment placed on a social media account. The alternative to this is a dynamic contamination status in which the contamination process is ongoing. This most often happens in environments. An example in the physical world is the constant noise, smells, and air pollution to which people are exposed. A digital example is that of a person, such as a parent, whose mere presence alters how another engages with an online community until they are no longer present.

Evaluation

Users evaluate perceived changes and information to determine how to act. If the perception is meaningful, the interaction will alter and thus be classed as a contaminated interaction. Often, however, perceptions are meaningless or trivial. For instance, the presence of background noise in an office or advertisements on a website may be imperceptible to users

and cause no altered interaction. A cautionary note, however, as perceptions need not be conscious to alter interactions.

As presented previously, there are three identified categories that communicate meaning to users: hygiene, utility, and territory. Hygiene is primarily concerned with evaluations of cleanliness. Territory is an evaluation of personal space. Utility is an evaluation of an object's technical, aesthetic, economic, social or other functional value. Together, these act as semantic drivers that influence meaning and subsequent interactions. The positive, negative, or neutral charge of these influences the presence of contamination.

Contaminated Interaction

Altered interactions are deemed contaminated. They are contaminated in that they deviate from how they would exist in a natural or undefiled condition (Duschinsky, 2011). Consistent with Verplank's perspective of interaction design (Moggridge, 2006), contaminated interaction is considered in terms of what people do, feel, and understand about a system. If any of these interactions are enhanced, interactions are thought to be positively contaminated. If diminished, they are thought to be negatively contaminated. If they change but cannot be considered positive or negative, they are considered are simply contaminated in a neutral way.

Judging whether interactions are positively or negatively contaminated requires a contextual understanding. The direction of contamination is marked by a shift in value statement. For instance, we may find that a person spends more time on a webpage when advertisement A is present when compared to B. We then know that the presence of the advertisement (i.e. the contaminant) alters (i.e. contaminates) the interaction with the webpage (i.e. the target object). The contaminated interaction remains neutral until it can be compared in some context in which it is considered positive or negative. Importantly, positive, negative and neutral contaminations can be considered from the user's point of view or from some external reference such as the designer/company's ideal.

Positive and Negative Contamination

In the baseball example shared in Section 6.1, the pitcher experienced a positively contaminated interaction with the ball because performance was better due to use. For the

batter, it was a negative contamination because his interaction with the ball was greatly impaired.

An expansion of the baseball example explains the current path a ball takes during a game. The purpose of this is to show how the meaning of an object can change positively and negatively between uses and users. The description which follows is summarized in Figure 6-7.

New baseballs do not have enough grip and have too much shine. Official rules dictate that mud must be rubbed on dozens of balls before each game and the umpire must ensure that the balls “are properly rubbed so that the gloss is removed” (MLB, n.d.). The contamination, in this context, is positive as the action enhances subsequent interactions. The value judgment is one of utility as the ball goes from unfit for use to fit for use.

Once in play, a ball may only be pitched a few times before deemed unfit for play. A ball may be unfit if it is discoloured or marked in some way. The contamination in this context is negative since it negatively threatens future play. Again, the value judgment reflects a utility driver as it moves from fit for play back to unfit for play.

Unfit balls are removed from play and may, through several channels, make their way to fans seated in the stands. The value a ball carries that has been used in play is higher than those that are new or even those that were rubbed and not used. In this context, contamination is positive as the value of the baseball increases. The value judgment goes from low to high as it has been touched by professional baseball players. This reflects territory since people have a desire to collect those things that have been used by famous others with a belief that the touched object carries the essence of those who used it before. Thus, in a way, the fan incorporates part of the baseball player into their personal space.

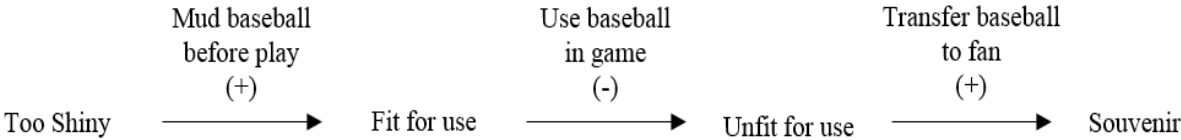


Figure 6-7 Example of contaminated interaction moving between uses and users in the context of baseball. Value judgments are given along baseline. The contaminating actions are given above each transition with the positive or negative value marker.

Study 6 Discussion

Through this work, the hope is to increase design knowledge around where and why contamination occurs so that designers can be better equipped to tackle it in the original design. This suggests a new way of framing design problems in which objects are constantly treated as they exist in a state of existence and how they may travel through many states during their lives. This becomes increasingly important when considering sustainability initiatives in which material is increasingly transferred within a system creating cycling rather than drawing on pure virgin material. This is also important in a digital world where things often change including the user experience.

Describing the situation is the first step in creating meaningful design solutions. The ontology presented in this study offers an overview of various scenarios under which contamination can occur. This is useful in that each scenario will likely require a different approach to address contamination. Future work should focus on creating a prescriptive approach to dealing with contaminated interaction. Such a prescriptive approach seems promising given the similarities in the drivers and the potential to identify overarching design strategies to cope with them.

There will likely be a finite number of strategies used to deal with contaminated interaction. For instance, the process of blocking someone in social media is no different, when abstracted, to blocking a contaminant (i.e. meat) from infecting the things next to it using some physical barrier. The term “blocking” might then be proposed as a general design strategy. Together, such a list of strategies could prove a useful technique for informing the direction of design.

A recurring theme in this research has been the up-front effort required with so many products. This effort might be thought of as the process of “breaking in” a product. Objects that are broken in improve as they conform to our personal style. Instruments and shoes, for instance, are broken in overtime and appreciate in how they respond to the user. Similarly, online music accounts, movie streaming services and cable programming also require an upfront effort to make them meaningful. This offers opportunities and challenges in the context of contamination.

Several offerings have designed features that allow you to customize an offering to each user. Cars, for instance, are broken in through adjustments of the mirrors, seat, steering wheel,

temperature control and audio preferences. New cars often will remember these preferences across users to allow for multiple people to have their own territory that transforms for their particular use (Baxter et al., 2015a). If a person enters with another's key that remembers the preferences, it will feel like they are out of place since the car presents an alternative set of preferences. A similar pattern is completed by Netflix when signing up for a new movie streaming account. When registering, it asks you to pick favourite movies that will be used to then guide the setup of *your* account. These same techniques can be used to better transition between users in other contexts and customize, to at least some extent, the user experience.

The issue may be more complicated with used items. In the case of previously-used goods, breaking in an object will often require a non-trivial extra step of cleansing the object before it can be fully used (Baxter et al., 2016a; McCracken, 1986). If the perceived benefit is small, users will not likely be willing to engage in this behaviour. For instance, in short-term access models, users may often opt to endure a negative experience rather than take steps to make it positive. Some evidence of this is seen with car-sharing schemes. Extra effort should go into enhancing the process of breaking in objects for use to minimize contamination.

6.6. Discussion

This chapter has presented and expanded upon the construct of contaminated interaction. In most instances in this chapter, contamination has been framed within the context of a single product moving through multiple states as perceived by the user, for instance, new to used. This is a useful frame to consider interactions with a product but it remains a limited use of the term contaminated interaction. For a more complete understanding, three possible frame of reference must be considered. The first frame of reference is that of the naturally occurring interaction. Used as the reference, any deviation from the natural state of things may be characterised as contaminated. An example of this is the aforementioned study which shows that soiled currency is spent differently than new, crisp currency (Muro and Noseworthy, 2013). If only examined from the reference point of what is typical (e.g. spending habits with new money) no judgement can be made on whether the change is good or bad. For this, another reference must be considered.

The second reference point is that of the user. The user may compare the present state of the object to some other state of the object. The mentioned example of comparing a used object to a new object demonstrates a consideration made from the user's reference point. In practice, this makes up many of scenarios related to user satisfaction. The third reference point is that of some external stakeholder. This is most often an organisation or another user who monitor use and outcomes of use. For example, A/B testing can indicate if a particular design of a product (or product messaging) taints the perception and use of a product.

The user and the external stakeholder may judge if an interaction has changed and, if so, whether it is a positive or negative change. This understanding can be complicated. For instance, if a company tells a user that an object is as good as new, it often makes them think about how someone else has used it (Ackerman and Hu, 2016). Here, both the user and the external stakeholder have a reference point but the shared information diminishes the value perceived by the user while this was undoubtedly the opposite of the intention from the company.

Reference points against which interactions are judged should also be considered in terms of how they are compared or contrasted. This is shown in a study on remanufactured equipment (Agrawal et al., 2015). When a company offers a remanufactured offering and a new offering, the two are compared to each other. This similarity leads users to devalue the new offering given the reference of the similar remanufactured offering. This appraisal changes, however, if the remanufactured offering is seen as a different offering supplied by some third party. In this case, the perceived contrast between the new offering and the third-party supplier's remanufactured offering causes users to value the new offering more highly than they otherwise would. These examples, together with those presented throughout the chapter, highlight the importance of accounting for contamination with the design of circular possessions.

6.7. Conclusion

This chapter provides depth of understanding around contaminated interaction and uncovers the indicators of use, drivers, and overall process of the contamination's occurrence. This contextualises something spoken about but not formally addressed within design. This was

achieved through an observation diary of things perceived to be used and a set of qualitative reports regarding things that are and are not contaminated. This provides a theoretical foundation to better understand use and contamination in the circular economy and can help designers analyse interactions that are contaminated in a robust way. More generally, this contributes to the design community by introducing a new design concept and the theoretical basis to explore it.

7. End of Life for the Simplest Circular Possessions

The value in reframing products as possessions in the circular economy lies, in part, in the focus on the entire time of possession—from acquisition to disposal. A circular possession is then a product which has been considered in terms of how it re-enters the system when people dispossess of it. This often requires individuals to complete several tasks including returning, evaluating and sorting the object. Importantly, dispossession can be thought of as a distinct concept from disposal in that disposal is actually discarding the object while dispossession is a mental shift in the relationship between a person and an object (Baxter and Childs, 2017). An example of this is seen in the evaluative process of placing items up for resale through platforms such as eBay in which case the object shifts from a possession to a resource and the fundamental relationship changes (Denegri-Knott and Molesworth, 2009). In a practical sense, this distinction may not always be necessary to make since dispossession and disposal may occur at the same time. Much can and should be done to design processes to aid users in seamlessly returning products into the larger system.

This chapter considers some of the simplest circular possessions—common recyclables and packaging. These are circular possessions to the extent that they enter and exit a person's possession and need to effectively return to the larger system. Two processes are considered: recycling and littering. Recycling clearly represents a familiar circular process. Littering is important since products are removed from the system altogether and are left in the environment or may otherwise be diverted to landfill. The intent is to show how these basic products and behaviours can be influenced as an example of designing circular possessions.

The investigation in this chapter also builds on the idea of contaminated interaction by examining how changes to the designed attributes of objects influence decisions around circulation. Specifically, two studies are conducted to investigate how changes in object attributes such as alterations to size, shape and colour influence perceptions and behaviours around recycling and littering¹. Framed this way, the changes to the object taint the perception a person would otherwise have of it and thus can be considered a type of contaminated interaction (this work was partly discussed in Chapter 5 as an example of contaminated interaction). This acts as one investigation into the larger issue of how the design of circular possessions needs to consider end-of-life interactions.

7.1. Valuing products at the point of disposal

Most interventions around proper disposal—understood as recycling and avoidance of littering in this chapter—have focused on changing the environment (e.g. bin placement, bin design, convenience of collection, clearing pre-existing litter, etc.) (De Kort et al., 2008; Domina and Koch, 2002; Ewing, 2001; Geller et al., 1979; Huffman et al., 1995; Saphores et al., 2006; Scott et al., 1977) or the consumer (e.g. messaging to change attitudes) (Baltes and Hayward, 1976; Bateson et al., 2013; Cialdini et al., 1990; Grasmick et al., 1991; Houghton, 1993; Huffman et al., 1995; Lord, 1994; Scott et al., 1977). The emphasis on infrastructure and messaging may be because waste management has been considered a municipal responsibility and has subsequently focused on interventions through which the municipality can exert control. More recently, producers have become far more interested in the proper disposal of waste. One reason for this is the development of global policies around extended producer responsibility (EPR) which posits that the responsibility for what happens to an object after the point of sale is shared with the producer of the object (Thomas Lindqvist, 2000). Packaging in particular is emphasized within EPR (Sakai et al., 2011). Business are also motivated by brand perception. The most littered objects come from the biggest brands in the world (Roper and Parker, 2006). The perception of such brands is diminished when the brand's packaging is seen as litter (Roper and Parker, 2013). As a result, several companies spend

¹ An earlier version of this chapter was published previously (Baxter et al., 2016b) but copyright was retained which allows the text to be presented here.

significant time trying to fight litter. In the UK, for example, McDonalds' employees conduct daily litter patrols to pick up litter on the streets ("McDonalds," n.d.).

With few exceptions, far less attention has been given to identifying how object-specific attributes can influence consumer disposal behaviours. Langley et al. suggest that making packaging easy to clean or separate could help facilitate proper disposal (Langley et al., 2011). They also note that even keen recyclers with good intentions often place items in the waste bin. Accordingly, it may be the object's attributes or how it is perceived following its use that impacts such disposal decisions (Williams et al., 1997). Trudel and Argo (Trudel et al., 2015; Trudel and Argo, 2013) have led research in which they demonstrate how changes in an objects' attributes (e.g. size and form) leads to drastic reductions in recycling behaviour. Using paper and soda cans as examples of commonly recycled objects, they manipulated either the size or the form of the object (e.g. cut the paper, dent the can). Participants with altered objects recycled at a rate less than half of the control (unaltered) condition. Wever et al. (2010) explored product attributes in the context of littering. Specifically, they sought to understand how littering is impacted by the attribute of 'reclosability'. The idea behind this was that an object that is reclosable may retain perceived usefulness and not be littered. The results of the reclosable study suggested that the attribute facilitated longer storage and subsequent use.

The objective of this chapter is to expand current understanding around how object attributes contribute to proper disposal. In the process, this chapter will shed light on the types of considerations that should go into designing circular possessions. The approach used in this research focuses on transformations that occur during the use of packaging such as changes in form, size, colour, and content. This is achieved through two studies. Study 7 explores the implicit associations people have between waste and recycling. Simple object transformations of commonly recycled objects cause an implicit bias to associate altered objects with waste in 82% of the responses. Study 8 explores object transformations in the context of littering. This study suggests that deformed, torn, disassembled and empty packaging all encourage littering. Findings did not support the hypothesis that objects that are wet, sticky, discoloured, or those with food remains significantly contribute to increased littering.

The focus of this research is to identify ways in which packaging can be (re)designed such that it alters behaviour. There are at least two design directions this research informs. First, packaging might be redesigned such that it does not change those attributes that discourage proper disposal during use. Changes can occur through designed interactions (e.g. 'tear here') or through interactions that are not designed (e.g. crumpling). Second, this approach helps to identify absolute attributes and characteristics that encourage proper disposal. These two options represent possible ways in which circular possessions could be created. This product-centric view is novel in approach but does not consider other elements of creating circular possessions such as altering the system in which an offering exists such that it then accounts for it. Other such accounts should also be considered when trying to achieve the ultimate aim of returning products to the system.

7.2. Study 7: The influence of physical product characteristics on Recycling

As products move through use they are evaluated to determine if they are to be reused or disposed of depending on the value attributed them by the user (Shipton and Fisher, 2010). The process of evaluating and discarding of an object can be a subconscious process leading to errors in how the packaging is categorized (Trudel et al., 2015; Trudel and Argo, 2013). Consistent with this prior work, the present study hypothesizes that alterations in the product packaging can contribute to users perceiving recyclables as waste. The purpose of this study is to measure this hypothesis by identifying the subconscious or implicit biases towards altered objects. This helps determine psychological reasons that contribute to the miscategorization of recycling and can aid in understanding how packaging design might influence proper recycling behaviour. An initial study uses field observation to inform the relationship between product attributes and the categorization of objects as recyclables or



Figure 7-1. a: recycling point where bin raids took place. b: image of waste examined during bin raid.

waste. This is followed by a study measuring the tendency to have a cognitive bias towards associating altered objects (e.g. torn or deformed) with waste rather than recycling.

Procedure

In a preliminary study, 'bin raids' were carried out to assess the types of objects that were incorrectly sorted as either recycling or waste. The raids were conducted, with permission and defined protocols, in three locations on two separate days at a university campus in London, England. Each location examined was a 'recycling point' where individuals can choose to discard objects in one of four bins: general waste, paper and card, glass, and cans, tins and plastic bottles. In some instances, an additional bin was available for batteries (see Figure

7-1a). This setting provides an opportunity for individuals to easily dispose of objects in the appropriate bin. Subsequently, it provides an interesting scenario to investigate common attributes among objects that were erroneously categorized. The contents of each bin were collected and taken to an outdoor location where it was emptied and photographed (see Figure 7-1b). The discarded objects were then examined across the piles from each bin to identify anything that was incorrectly sorted. Observations were recorded with attention given to the attributes of the erroneously sorted objects.

The bin raids were followed by an effort to quantify the unconscious or implicit associations users have with waste. This was done using an Implicit Association Test (IAT). The IAT measures the implicit association between categories (e.g. altered or unaltered packaging) and attributes (e.g. waste or recycling). This test is particularly useful in scenarios in which a decision must be made between two categories (e.g. placing items in a waste or recycling bin). The IAT uses a series of timed activities in which participants are tasked with sorting stimuli that appear in the middle of a screen to target categories and attributes on either side of the screen. An example is shown in Figure 7-2. In this figure, the image on the left shows an altered water bottle that would be grouped on the right side with the category *altered objects*. The image on the right shows the word *garbage* which would be grouped with *waste words*. Concepts that have come to be associated with each other are thought to be more readily grouped than those with little or no association (Nosek et al., 2002). Thus, by measuring the response time needed to group stimuli to categories an overall association can be found. The overall association is represented by an IAT score, or d-value, which is calculated using the scoring algorithm developed by (Greenwald et al., 2003). Possible d-values range from -2 to



Figure 7-2: Two screen shots of IAT tasks.

+2. The break points for slight, moderate, and strong effect sizes are positive or negative 0.15, 0.35, and 0.65, respectively.

A custom IAT was created using software at www.SocialSci.com to measure the implicit associations of altered vs unaltered common recyclables (e.g. office paper, cardboard, soda can, water bottle). Following the collection of initial demographic information, participants were asked to sort stimuli according to how they can be grouped in the following: “altered objects,” “unaltered objects,” “recycling words,” and “waste words”. The altered and unaltered objects categories featured images of commonly recycled items. Examples of these items are shown in Figure 7-3. The categories of recycling words and waste words consisted of words that are commonly associated with each of those. For the recycling category, the words sustainable, green, environmentally friendly, and recycle were used. For the waste category, the words trash, rubbish, landfill, and waste were used. If there is an implicit bias to associate altered packaging with one of the categories then a difference in response times represented in the d-scores is expected. In this study, positive d-scores meant that respondents associated altered objects with waste, rather than recycling. While this method has been used with other packaging studies (Parise and Spence, 2012; Piqueras-Fizman et al., 2012; Piqueras-Fizman and Spence, 2011; Tate et al., 2014), this seems to be the first time it has been applied to object attributes and disposal categories.



Figure 7-3: Examples of altered and unaltered objects used in the IAT

Following the IAT, participant self-reported attitudes and behaviours towards recycling were captured. To do this, participants were posed with the following statements: I feel recycling is important; I recycle most of the time; I consciously think about whether something should be sorted in the recycling or the trash. Responses were recorded on a five-point scale from strongly agree to strongly disagree.

Participants

An initial group of 31 volunteers in Southeast England was used to validate the method. A subsequent 153 participants were recruited from Amazon Mechanical Turk to take the survey. Participants from mechanical Turk received USD \$1 for taking the survey which, on average, took under six minutes to perform. Each participant completed the IAT and survey questions at their own computer but detailed instructions were provided. Consistent with the guidelines presented by (Greenwald et al., 2003), individual trials were discarded that took longer than 10,000 ms as were subjects who had more than 10% of trials under 300 ms showing that they had simply rushed through the task. In total, fifteen subjects were discarded due to timing issues or that they did not complete the entire survey resulting in 169 respondents (83 Female, $M=36.2$ years, $SD=9.7$). There was some difference in age between the volunteers (16 Female, $M = 32.0$ years, $SD = 9.7$) and those recruited from Mechanical Turk (67 Female, $M = 37.2$ years, $SD = 9.4$) but from here on, all findings consider all participants unless stated otherwise.

Results and Discussion

The bin raids confirmed a significant presence of miscategorised objects. These varied across product categories and not enough of any one category was identified to the point that statistical measures proved useful. There were, however, interesting anecdotal findings. For example, items were often placed in the general waste stream when they contained multiple types of recyclable materials such as plastic and card together. The same was true of objects with food on them. This supports the idea that individuals default to categorizing something as waste unless it is clear that it is recycling. Also in the bin raids were many altered objects. Consistent with (Trudel and Argo, 2013), paper that is deformed in some way was often included with waste rather than recycling. This was also true of soft plastics such as candy packages that easily alter form during use.

The most prominently miscategorised item was the paper coffee cup. These cups did not generally show signs that they had been altered other than, perhaps, some stains. Examining this cup is therefore beyond the scope of the current study in terms of object transformations. It does, however, offer interesting insight with regard to miscategorisation. The cup was often placed in the general waste bin. This is the correct choice since the recycling contractors are not able to deal with the coating on the cup for this region. It was also often placed in the paper and card bin. Presumably, this is because of its paper-based composition. This error may be compounded by the fact that some stores include the recycling logo on the cup which can mislead consumers to think that it is recyclable in the majority of cases (Webster, 2016). Interestingly, the coffee cups were also frequently found amongst the contents of the bin designated for ‘cans, tins & plastic bottles.’ One reason for this may be that the geometrical attribute of the cup—its cylindrical form—suggested that it should be categorized together with the other cylindrical items. This lends support to the idea that items are miscategorised according to their attributes.

The IAT test also supports the idea that objects are miscategorised according to their attributes. The inclusive sample of 169 participants have an average IAT score of 0.587 (SD =

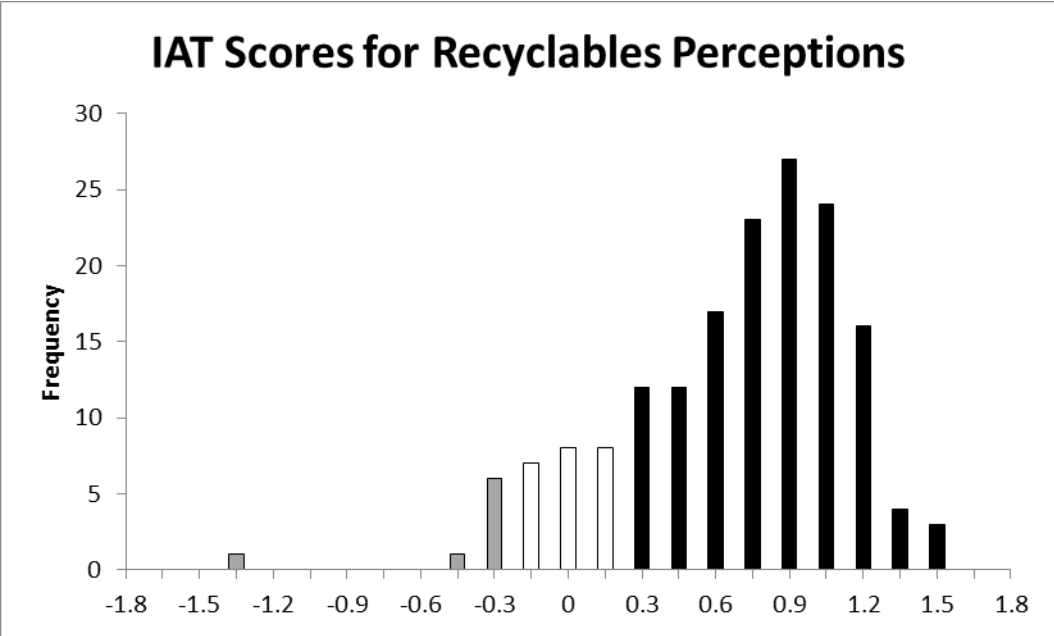


Figure 7-4: Results from the IAT. Black represents those who associate altered objects with waste, white is neutral, and grey indicates participants who associated altered objects with recycling.

0.467). In total, 138 participants (82%) had at least a slight association between altered objects and waste but perhaps more significantly, 90 participants (53%) showed a strong association between waste and altered objects (see Figure 7-4). Only 15 participants (9%) showed any kind of bias in the opposite direction. These results show a remarkable tendency for people to associate altered objects as waste.

The questions following the IAT revealed two categories in which the volunteers differed from the MTurk Participants. Volunteers were more likely to say that recycling was important ($M = 4.74$, $SD = 0.51$) than MTurk respondents ($M = 4.32$, $SD = 0.76$, $p < 0.01$). Volunteers were also more likely to say that they consciously sort the trash and recycling ($M = 4.45$, $SD = 0.57$) than MTurk respondents ($M = 3.91$, $SD = 1.09$, $p < 0.01$). This is not surprising since most of the volunteers came from an environmentally conscious group within a university. There was, however, no significant difference in respondents saying they sort recycling most of the time ($p = 0.28$) nor in overall IAT scores ($p = 0.38$).

If this is truly an implicit effect, the self-reported indicators are not expected to influence the IAT scores. To check this, multiple regressions were run on the data. Age was included in this analysis thinking that perhaps certain age groups have developed different types of associations with the indicators. Neither age nor any of the questions were found to have a significant impact on IAT scores. This emphasizes the significance of the effect regardless of user attitudes or behaviours.

7.3. Study 8: The influence of physical product characteristics on littering

The littering study considers how changes in packaging might impact feelings and behaviours towards littering. This strand of work was informed by first conducting over 40 hours of observations in which littering behaviour and fallen objects were analysed to try to identify object attributes that might contribute to littering. From this developed two hypotheses. First, altered objects may be perceived as more acceptable to litter due to changes in shape, size, colour, or other attributes. Under this hypothesis, the absolute property of size should also influence littering. While this seemed to be a trend, it has not been shown to influence behaviour in previous work dealing with how size impacts the littering of leaflets (Krauss et al., 1996). Second, objects are more likely to be littered as they become disgusting due to use.

For example, an object that is wet, sticky, has food remains on it or changes colour may produce a less-comfortable interaction with the user and they will be more likely to litter it. Work by Wever et al. (2010) lends support to this hypothesis in research where they considered the difference between containers that are reclosable and those that are not. Their work showed that more reclosable containers were more frequently taken home suggesting that consumers may be willing to carry certain objects longer than others.

Research on littering can be difficult. Unlike recycling where there are only two possible appropriate behaviours at the point of choosing the bin, littering consists of several behaviours. Littering can occur while people travel with an object making it difficult to track objects. The act of littering is often done discretely making it difficult to observe. Finally, littering occurs across a variety of items and tracking one single item can prove problematic. This research acknowledges these limitations. To compensate, effort is made to try to distinguish between twelve types of behaviours and across many observations. Rather than tracking a product attribute relevant to one single type of packaging, this study looks at types of transformations that might be generalized across packaging types. This work was carried out in collaboration with Keep Britain Tidy and was sponsored by two global food companies.

Procedure

From the initial observations of littering and littered objects, six types of object transformations were identified. To test the first hypothesis—objects may become more acceptable to litter with transformations—three types of transformations were considered that can occur during use: packaging is (not) empty; packaging has extensive, minor or no changes; the object is disassembled or torn apart. The idea behind the object being empty or not has to do with how conspicuous littering is when the contents, such as food, are not fully consumed. The other two types of transformations have to do with making the object smaller so that it is perceived to be more appropriate to discard in some way. To test the second hypothesis—object transformations can make objects unpleasant to continue carrying—another three types of transformations were identified: the object changes colour; the object appears to be wet, sticky, or both; and the object has remains (e.g. sauce) on it.

Due to the nature of this work it was very difficult to try to quantify the object transformations. It seemed unreasonable, for example, to rate how sticky something is or how much something has been deformed. Instead, a subjective assessment of the object transformations is made during observation. Extensive observational studies were carried out to test the hypotheses at five urban locations throughout London, England. The observations were made by research assistants who were formally trained in recording observations on a custom form. The observation form consisted of recording typical information about the date, time, and area but also included much detailed information. Specifically, the form specifies between 32 types of littered objects, 12 behaviours, the six object transformations above as well as information about the behavioural setting, i.e. demographics about the litterer, any people in proximity and any pre-existing litter in the vicinity. A breakdown of the types of packaging recorded and the types of littering behaviours is found in Table 7-1.

All observations were transferred to digital form and, where needed, the data was cleaned. For example, in instances where multiple behaviours were recorded on a single line this was corrected in the data. The data were then coded into littering and non-littering behaviours (Coded as 1 and 0, respectively). The difference here was made according to the assumed intention of the person. Intentional behaviours were determined to be the following coded behaviours: flagrant – fling/throw, drop with intent, inch away/left behind, sweep, accidental drop: noticed and left. Non-littering behaviours were the following: binned, placed next to bin, shoot and miss, unintentional drop, recycled. The non-littering category included items that are technically littering but an effort was made to get it to the waste bin (e.g. shoot and miss, placed next to bin) or it was not noticed by the user. In those cases, the user either made a positive decision about disposal but perhaps did not follow through or made no decision at all. Subsequently, this does not tell us much about how object transformations impact disposal decisions. Two behaviours were excluded from this analysis—wedge and leave area with food—because these cannot be accounted for in terms of intentional or unintentional conditions. In the case of the wedge, little information is known about where this took place so it is difficult to assess. If it took place by the bin, it may not be considered an intentional drop, if it took place away from a bin, however, it would be intentional. In the case of leaving the area with the food the behaviour was inconclusive.

Next, all data were analysed through statistical analysis to determine relationships between the rate of litter and object transformations. For this, a chi-squared test was used. Objects were examined as they relate back to the hypotheses as large or small groups to gain insights. To prevent skewed data, cigarettes and gum, two of the most prolific objects in the study, were removed from the analysis unless it was relevant to the data on hand.

Results and Discussion

Initially, 2707 unique observations were gathered through the analysis. Many of the observations, however, included multiple observations that the researcher had included on the same line. Once this was accounted for, there was a total of 2823 observations. The observer could not always determine object transformations resulting in a smaller subset of observations that were useful for any given analysis. The following paragraphs report on the analysis of the recorded object transformations as they relate to littering. Each analysis reports the number of objects counted (N) that are applicable to the study at hand.

Objects that still contain material (e.g. food) in them are often larger and more conspicuous than others. These objects may also carry more value in them. Thus, the result is fewer littered objects. This was determined by assessing the (not) empty objects from the observational forms. When assessing objects across all product categories—except gum and cigarettes—for which there is information (N = 721), a mildly significant effect is found for *not empty* objects being littered less ($p = 0.08$). From the observations, two categories were expected to be particularly significant here: cups and wrappers. The effect became more significant when only considering the categories dealing with cups (N = 297, $p < 0.05$). Surprisingly, there was no effect seen with select wrappers such as crisp packets, aluminium foil, paper bag, and sandwich box (N = 317, $p = 0.97$).

Object changes refers to deformities in the object's shape and size. For example, a soda can with a small dent in it would be coded as a minor change while a smashed can is coded as an extensive change. The observations showed that alterations in the object's shape and size could contribute to discretely littering. The resulting hypothesis was that such changes would lead to increased littering due to a less conspicuous object. Objects that were commonly reported to undergo these changes included various types of wrappers and paper such as train

tickets or flyers. Indeed, the wrappers category saw a significant effect on littering rates from changes in the object ($N = 225$, $p < 0.05$). As expected, paper and card also saw a significant effect ($N = 67$, $p < 0.05$).

As in the previous section about product changes, disassembled or torn objects can create a smaller and less conspicuous object. Thus, the expectation is that such objects would be littered more readily. Across all categories this indeed had a significant effect. Objects that were torn were much more likely to be littered ($N = 1014$, $p < 0.05$). The most common objects to be torn were types of wrappers and paper such as bus tickets and flyers. Paper did show to be littered more once it was torn ($N = 105$, $p < 0.01$). Wrappers, however, did not show any such effect ($N = 265$, $p = 0.74$). Disassembled objects too had an impact across all the product categories ($N = 952$, $p < 0.01$). Examples of disassembled packaging include a soft drink cup that consists of cup, lid, and straw, or layered packaging where there may be a cardboard box encompassing a second set of plastic film packaging. Expectedly, disassembled cups were more likely to be littered than those that were not ($N = 356$, $p < 0.001$). There were too few observations with layered packaging to make a reasonable analysis.

Changes in an object's colour can result from normal use of the packaging such as the oil from a meal saturating the paper around it. Consistent with this example, wrappers of some kind, including paper bags, were the most common items to experience a colour change. These are thought to evoke disgust for the user and cause more willingness to litter the objects. Across all objects (other than gum and cigarettes), however, colour change does not lead to increased littering ($N = 1065$, $p = 0.74$). If considering only wrappers, there remains no effect ($N = 502$, $p = 0.86$). This was contrary to the hypothesis. A further investigation of the observations suggests that there may be other things that impact the change in colour that is not disgusting to the user and would not contribute to increased littering in those situations.

Table 7-1 Comparison of observed behaviours and accompanying packaging types.

Classification*	Cigarette butt	Cigarette related	Gum	1: Soft drinks cup	2: Plastic cup	3: Plastic bottle	4: Can	5: Glass	6: Hot drinks cup	7: Other (Specify)	Food packaging - crisp packet, confectionery	Food packaging - polystyrene box/tray	Food packaging – cardboard box	Food packaging – plastic box/bowl	Food packaging – sandwich box	Food packaging – paper bag	Food packaging – aluminium foil wrapper	Food packaging – plastic/cellophane bag/wrapper	Food packaging – small packets (sugar, ketchup, etc)	Food packaging – other (please specify in comments)	Napkins	Straws	Utensils (fork, knife, spoon, stirrer...)	Food	Cellophane wrapping	Paper – train/bus tickets, receipts, flyers, leaflets	Paper – tissue	Card and board packaging	Newspaper/magazine	Plastic bottles/packaging (non-food or drinks related)	Plastic bags	Textiles	General litter (other)/Unsure * specify	sum
1	240	35	29	83	19	55	44	10	78	4	55	14	53	20	51	175	8	50	4	15	36	8	10	39	7	86	58	12	9	2	15	3	63	1390
2	10	1	0	1	1	1	2	3	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	2	2	1	2	0	0	2	0	0	0	32
3	3	1	1	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	12
4	135	0	0	5	0	1	3	0	0	0	3	2	3	3	5	0	2	3	2	7	0	0	9	1	2	2	0	0	0	0	0	0	4	195
5	398	10	4	4	3	1	3	2	4	1	5	1	4	3	1	7	1	5	4	3	5	3	0	7	4	11	3	1	2	1	2	0	6	509
6	4	2	0	12	5	3	8	1	14	0	7	0	8	0	7	12	0	2	0	3	3	2	0	0	0	0	0	0	1	0	1	0	0	95
7	2	0	0	0	0	1	1	1	3	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	13
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9	0	2	0	0	0	0	0	0	0	0	1	0	0	1	1	1	3	1	0	2	1	0	4	0	4	0	0	0	1	0	0	0	0	22
10	2	1	0	1	0	0	0	0	0	0	3	0	1	0	1	0	1	2	1	0	0	1	6	0	3	0	0	0	0	0	0	0	2	25
11	0	0	0	115	24	16	8	0	41	0	10	4	18	14	5	165	0	4	3	0	1	2	4	2	0	0	3	0	0	0	0	0	0	439
12	1	1	2	4	3	9	9	1	3	0	1	0	2	3	5	6	0	3	0	0	2	1	0	1	0	16	11	0	1	0	1	1	3	90
	795	53	36	225	56	87	78	18	143	5	87	22	91	43	74	376	10	70	17	24	56	17	15	69	14	126	80	15	14	4	21	4	78	2823

*The behaviours are classified as follows: 1 = Binned litter; 2 = Placed next to bin; 3 = Shoot and miss; 4 = Fling/throw; 5 = Drop with intent; 6 = Inch away/left behind; 7 = Wedge; 8 = Sweep; 9 = Accidental drop – did not notice; 10 = Accidental drop – noticed and left; 11 = Left area with food; 12 = Recycled.

Objects that are wet and/or sticky are less pleasant to hold. Consequently, more frequent littering of wet or sticky objects was expected. As anticipated, wrappers of different types were the most commonly recorded as being wet, sticky or both. Contrary to the prediction, however, no significant effect was seen across wrappers ($N = 364$, $p = 0.55$). Only when considering all categories, including gum and cigarettes, is there a significant effect ($N = 1367$, $p < 0.01$). This is not surprising since gum would greatly skew these results.

Residue left on a package, such as sauce, could lead users to feel uneasy about holding the object leading to increased littering. The data does not support this hypothesis with no significant effect across all categories besides gum and cigarettes ($N = 1057$, $p = 0.53$). When considering only select types of wrappers that may be subjected to this type of condition, the effect is still not significant ($N = 365$, $p = 0.16$).

7.4. Discussion

The two studies in this chapter have indicated how changes in packaging attributes, such as alterations in shape, colour, or size, influence two disposal behaviours: recycling and littering. 82% of respondents showed at least a slight effect and 53% showed a strong effect towards associating altered objects with waste. Littering behaviour observations indicated that littering is influenced by deformed, torn, disassembled, and partially full packaging. No significant effect was found regarding packaging that is wet, sticky, has undergone colour changes or that is has remains on it. These findings suggest that the (re)design of packaging can significantly influence proper disposal. Based on this, packaging design might be influenced in three ways. First, the titular 'Tear Here' is the epitome of the scripts that are designed into packaging. So many packaging designs include scissor guides, perforated lines, and pull tabs. In the cases where object alterations lead to negative perceptions, these might be changed. The redesign of packaging such that it does not change might be considered a scripted strategy since it guides the user in how to use it (Wever et al., 2008). Perhaps more accurately in this case, it does not misguide the user. The second implication for design considers how users alter objects through their natural (i.e. unscripted) interactions with objects. By altering physical characteristics such as stiffness, some interactions might be prevented that could encourage improper disposal. These first two implications deal with preventing changes in the packaging to preserve properties that are associated with recycling

and non-littering. The third design implication involves identifying absolute or inherent properties that encourage proper disposal. By identifying how changes in packaging contribute to waste or littering perceptions may begin to extract design heuristics that inform design for proper disposal. The recycling study, for example, exposes the unconscious biases around recycling. This suggests that any design for recycling might do well to include cues that force individuals to consciously make decisions. Likewise, the littering study suggests that changes contribute to a potentially less conspicuous form of littering. A design intervention might then focus on designing conspicuous objects.

Significantly, the effects of altered objects on proper disposal are not trivial. There are published empirical studies that show how object changes can lead to more than a 50% reduction in recycling (Trudel et al., 2015; Trudel and Argo, 2013). Similarly, the present work on recycling consistently showed categories in which the statistically expected rate of litter was half of the actual rate under some conditions. This avenue of research seems to be a ripe area for considering packaging design. This is particularly promising in terms of companies taking more control over how they can influence disposal.

The recycling study confirms that individuals miscategorise altered objects as waste rather than recycling. This research advances this thinking by quantifying the extent to which that miscategorisation occurs in a novel method. The use of the Implicit Association Test could be expanded to other studies on packaging design including how packaging design influences sustainable perceptions. One possible direction would look at perceptions of personal reuse of various types of objects.

The litter study shows clear support for the idea that changes in object attributes can lead to increased littering. Some areas such as deformations of various types, seem like a promising area to investigate further. Future studies should confirm this through trials with different packaging. The littering study did not show significant findings with objects that were wet, sticky, changed in colour or had residue on them. One possible explanation for this is that it can be difficult to assess some of these attributes through observation. Determining if an object is wet or sticky, for example, might require a more intimate examination of the litter than is possible or practical. Any future analysis might try to carefully consider these attributes across specific types of objects.

More broadly, this work provides commentary on two important elements of designing circular possessions. The first is that much can still be determined in the relation between disposal decisions and design decisions. Research should focus on developing further knowledge regarding how and why individuals dispose of things and what environmental or product-specific features influence this. This study showed opportunity to redesign objects that are commonly littered or not recycled in a way that the design of the object itself could influence these towards remaining in the system. Combined with other work on disposal such as municipal interventions, this shows the extent to which designing circular possessions can and should be an objective of all relevant stakeholders throughout the system. This work also relates back to contaminated interaction. The studies in this chapter act as case studies in how contaminated interaction can directly result in activities that threaten the circulation of material flows.

7.5. Conclusion

This chapter highlights concepts from different parts of the thesis in a specific investigation. The first part of the thesis argues for the need to design possessions which includes considering the entire length of use a product is in and ensuring design accounts for end-of-life decisions. The studies in this chapter suggest that simple changes to packaging could make significant differences in those disposal decisions. The latter part of the thesis explores the idea of contaminated interaction. This chapter illustrates contaminated interaction as the changes to packaging fundamentally alter how people would otherwise interact. The chapter also furthers research specifically in the areas of behaviour change as it relates to proper disposal and provides promising direction for an under-explored area of inquiry—how product-level design decisions can nudge more sustainable disposal.

8. Discussion and Conclusions

Designing for the circular economy requires a fundamental shift in thinking about the relationship people form with objects. This relationship can be considered in terms of possession as products move in and out of a person's stewardship before returning to the system. This shift positions individual's as central actors within the circular economy who are critical to the circulation of material flows (Chapter 2). This view of *circular possessions* differs from traditional ownership in two key dimensions: the length of use is now important to consider in terms of extending product longevity and ensuring positive user experience beyond the point of sale; and the number of users engaging with a product increases as products are recirculated giving rise to issues surrounding contamination (Chapter 1).

In addition to examining the entire possession of a product, this thesis has argued that successful deployment of the circular economy hinges on designers' ability to understand how users obtain product-level meaning. Accordingly, the empirical studies address this in two key themes: what meaning underpins ownership and how is this meaning constructed in changing contexts (Chapters 3 & 4) and how does a change in this value result from and influence circulation (Chapters 5, 6, & 7). The next sections discuss the conclusions and implications drawn from this work before discussing implications for design and directions for future work.

8.1. Conclusions and key findings

The aim of this thesis was to provide needed understanding around user interactions central to successful material flow. This involved generating fundamental understanding upon which design practice and design research can build. The nature of this work was such that it sought to address broad issues rather than one specific area in detail. This largely limits the work to theoretical contributions related to design context, approaches and rationale. Omitted from

this is a clear demonstration of a designed solution given new understanding. The research did, however, provide ample reflection on the nuances which comprise many pressing issues and as a result, several suggestions for future work are discussed below.

The research provided clear support for the need to address the design of circular possessions in a broader sense than has previously been done. This requires a fundamental shift in thinking for most designers in multiple areas. The most familiar shift is that of addressing the entire interaction a user has with a product from the point of acquisition to the point the user returns the product to the system. Less obvious is the attention needed around the feeling of possession or ownership and the idea of contaminated interaction. Neglect of these issues is partially attributable to how new the scenarios of user interaction are. The research also has highlighted the need for multiple stakeholder involvement in many cases dealing with ownership and contamination with circular offerings. At present, much of what is designed in the circular economy is done so in silos of design practice. For instance, an OEM may design a product which a group of designers may then fit within a service offering. This separates the collaboration needed for many circular design activities. A more holistic approach would bring together designers involved in the design of the entire circular possession. This will likely include those involved with the design of the product, the service, and the system forces in which the offering exists.

This research has demonstrated needed frameworks and models to understand how design activities can be structured to achieve desired outcomes and how various design teams can contribute to the overall process. Future work may successfully identify concrete design methods and tools to address this new approach of designing circular possessions. A summary of key findings upon which methods and tools can build is summarised below before further discussion regarding how designers should approach designing circular possessions now and in conjunction with future work.

The design of products, with the services and systems which support them, should be considered in terms of how value is created for the user. Chapter 1 argues that this human-centred focus of designing in the circular economy reframes product design as possession design as it emphasizes entire lifecycle considerations of the product. The designed user experience should then be one that is experientially transferrable—positive, or at least

neutral, experiences are maintained as a product moves between uses and users. Maintaining user value as it moves between uses is thought to be a durable user experience as it moves through the duration of use. This durability includes aspects such as product longevity but also develops concerns ensuring that effort goes into ensuring that users have a positive experience at the point of disposal as well as the point of sale. Maintaining value as it moves between users is thought to be a resilient user experience as it can move between users while retaining the features which make it valuable. This resilience is critical in sustaining meaningful interactions in access-based consumption but also surfaces in recycling and remanufacturing contexts.

Prior work has not generally placed emphasis on the role of the user in the circulation of material. Chapter 2 discusses how reframing the consumer as a user does not fully represent what role(s) the user plays in the circular economy. This chapter identifies six behaviours critical to the circulation of material in the circular economy. This gives human interaction a central role in the circular economy and places individuals as key actors in material circulation. Thus, while it is perhaps easier to refer to humans in the system as users, they might more accurately be thought of transitioning from consumers to circulators.

The concept of possession is important in creating meaning for users in personal and interpersonal interactions with products. Chapter 3 discusses the shortcomings of current offerings in terms of how they address possession or ownership before presenting an ownership framework. The main issue here is that ownership is typically discussed from a legal perspective but not an interactive one that gives the feeling of psychological ownership. The framework builds on understanding how the motives and routes of psychological ownership theory are influenced by primary and auxiliary stakeholders. This is particularly useful in creating new business models such as access-based consumption in which ownership exists in a hybrid state shared between the user and some company who facilitates transactions. This approach to ownership aids designers in navigating feelings of ownership and understanding how such feelings can be influenced.

Feelings of ownership induce a sense of stewardship, attachment, and loss aversion making it a useful construct in influencing consumption patterns. Chapter 4 links the framework presented in the previous chapter with attachment and decisions to keep, care for, or discard

products. A deeper understanding of the interactions performed through the routes inform attachment and decisions to keep or discard an object. The routes of control and self-investment are active in that they typically require the user to act upon the target object, whereas developing intimate knowledge comes from communication to the user from the object or other sources. Control deals with spatial manipulation of the object, configuration of settings, and temporal considerations like the ability to transform the object over time. Self-investment includes the mental, emotional, financial or other effort put into an object and the ability to recall these. Intimate knowledge is as much about the content, timing, and medium of communication as much as to the resulting experience. The resulting process diagram and affordance principles can be used to influence object attachment. Product longevity benefits from the resulting framework and associated affordance principles as it offers a means of developing object attachment which is driven by a desire to fulfil the motives in the framework and is realized through the routes. These same motives and routes are useful in determining reasons for keeping and discarding objects. Finally, findings also provide useful insight into why a person may choose to adopt a second-hand item rather than buy it new. This aids the development of meaningful access-based consumption models.

Circular possession need to mitigate contaminated value. Chapter 5 identifies three types of contamination impacting circular material flows: technical, systemic, and interaction. Technical contamination is about how the presence of a contaminant or an altered material property renders an object unfit for purpose. Systemic contamination concerns the purity of material flows and is about efficiency. Contaminated interaction is about ideal interactions for material circulation. Technical and systemic contamination do threaten the circulation of material flows but are incomplete without understanding contaminated interaction. Through an examination of case studies, contaminated interaction was shown to act as a barrier to material circulation in the form of *hindered circulation*, *downcycling* and *disposal*.

Addressing contaminated interaction requires a deeper understanding of the phenomenon. Chapter 6 examines the indicators of use which contribute to miscategorising a product and develops an ontology for contaminated interaction. Indicators of use are found to exist at five levels: knowledge about the object, accompanying objects, object settings and specific product characteristics and states. Characteristics and states can be linked to material

sensorial properties in order to better understand the specific mechanisms which signal use. Not all use is seen as a negative thing. Instead, this is context specific. Concerns over hygiene, utility and territory emerge as the principal drivers of contaminated interaction. A second study was used to develop the understanding of contaminated interaction into an ontological model. The model was informed by relevant literature and an analysis of reported user experiences. The resulting model describes how a contaminator creates a contaminant in each situation that changes user evaluation of an object thus producing a contaminated interaction which can be positive, negative, or neutral. Negative (positive) contamination results in users avoiding (engaging), misusing (better using), or negatively (positively) experiencing offerings. This understanding better equips designers to analyse and describe the contamination processes underlying the contextual issue they are facing.

Chapter 7 presents two investigations into how simple changes in product design can influence the circulation of material. Two studies on the proper disposal (i.e. recycling and littering) of packaging show that object alterations change perceptions and behaviours. Strategies for redesigning packaging are offered to ensure better circulation of the material. First, the designed changes in the packing (i.e. perforated pull tabs) can be redesigned to limit the changes that occur in the packaging. Thus, the first strategy would entail changing the designed ways in which packaging is altered during use. Second, the packaging can be built in a way that it is more difficult to alter them. This strategy then entails altering the material characteristics that allow crumpling, tearing, discoloration or other alterations to maintain a given perception. This work acts as an example of how the design of even simple objects needs to be rethought to create circular possessions which are intentionally made to return to the system after use. The studies in this chapter also demonstrate measured examples of contaminated interaction.

8.2. Guidelines for designing circular possessions

The terms circular and possession convey strong implications with regards to design. Circular design is about creating and maintaining system-level architecture which enables the circulation of materials. Designing possessions is about creating and maintaining meaningful interactions. In isolation, both terms fall short of the type of design needed for the successful implementation of the circular economy.

Circular design, as it is typically used, is about understanding and facilitating the opportunities and needs associated with closing material loops. Opportunities often focus on what can be done, such as better realising the latent value of seldom used products (e.g. cars, tools, toys) through circular business models. This is addressed through facilitating the logistics of what needs to happen through services or other means. Needs focus on what must be done to close material loops such as getting users to return their belongings to the system at the end of use. Like most policy, this is often addressed through some combination of financial rewards (fines) for compliance (defiance). The *what* and *how* of these approaches are typically well analysed. The holdup is the *why* from a human-centred perspective. In other words, what meaningful value are people getting from their interactions in these situations.

Designing possessions, as it may intuitively imply, is about understanding and facilitating meaningful interactions with personal property. Often, these meaningful interactions are about enabling ultimate control so a person can claim as much value from the possession as possible. This view of possession has been woven into our current economic models. For instance, Adam Smith, the ‘Father of Modern Economics’ has said that it is a sacred law of justice to guard a person’s property (Smith, 1790). The resulting design of products, services, and legal or societal infrastructure has evolved over time to ensure the present form of ownership. In other words, designing possessions is primarily about maintaining the linear economic model we have and leaves little room for rethinking system-level change.

The design of circular possessions is primarily about achieving realignment of human-centred design and the circular economy in research and practice. The terms circular and possession qualify the term as a whole. This type of design is no longer dehumanised or constrained to linear understandings. Instead, the design of circular possessions is about creating and

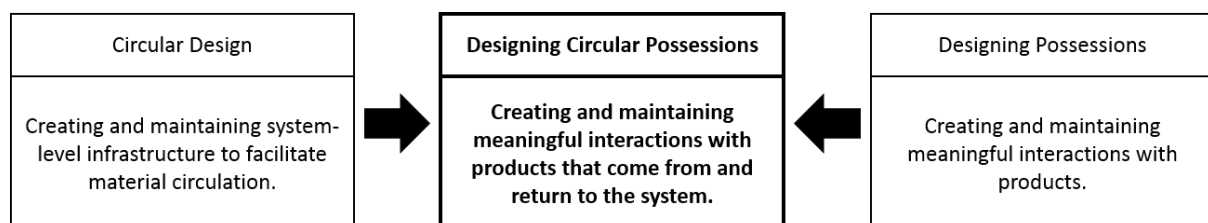


Figure 8-1 Designing circular possessions as a new frame for design.

maintaining meaningful interactions with products that come from and return to the system, see Figure 8-1.

Consistent with the structure and content of this thesis, designers in the Circular Economy should follow a three-step process to ensure their products are optimised for circulation from a human perspective. First, designers should identify those behaviours that are essential to the circulation of the material. As discussed in Chapter 2, this will include understanding key behaviours during adoption, use, and disposal of a product. At this level of analysis, the focus is on what users need to do—the actual behaviours they will engage in. The inherent value in this is the systems thinking designers are forced to adopt when considering the entire use cycle of a product. This ensures responsibility will remain with the designer to understand how the product, the service and the context all have been designed to facilitate the identified behaviours. The implicit secondary part to this step is the focus on understanding how to enable these behaviours in the best way possible. In other words, designers should seek to make each behaviour as simple and enjoyable as possible. The outcome of the successful completion of this step is a more holistic approach to responsible design within the circular economy.

The second step is to understand the significance of *feeling* a degree of ownership for the product in the user's possession. Of course, if the circular offering is replacing traditional ownership (e.g. with an access-based model) the consideration should contrast the significance of not feeling ownership and how that may alter the interaction with the product offering. Consistent with Chapters 3 and 4, the designer should consider factors such as how a sense of ownership may fulfil fundamental motives, how various actors play a role in enabling such feelings of ownership and how feeling ownership could lead to behavioural outcomes such as influencing the care and maintenance around a product. Feelings of ownership are often dynamic and should be considered in their time-dependent condition. The value in this step is the focus on appreciating the nuances in ownership which guide many of the relevant interactions for circular material flows. The fulfilment of this step represents a dramatic shift from current work in which ownership is mostly considered a legal consideration rather than one for interaction and experience designers to confront.

The third step in the circular possession design approach is to understand and anticipate how the meaning of a circular offering can become tainted as it moves between uses and users. This focus on contaminated interactions is unique from the other steps in that it focuses on products as they exist across multiple cycles, not just as they move through a single use cycle. Consistent with Chapters 5 and 6, consideration should be made for how the perception of the circular offering changes, what fundamental drivers contribute to this change, and how the change influences circular material flows. Designers should seek to gain a deeper understanding of the characteristics that describe the given contaminated interaction and should seek ways to mitigate negative contamination. The value in this step is in the attention to the time-dependent nature of perceived value. The completion of this step helps focus on maintaining perceived value as well as technical or more objective types of value and accordingly.

8.3. Directions for future research

This thesis has reframed what it means to design products and their supporting services and systems within the circular economy. In short, this can be thought of in terms of how meaning and value is created and maintained for individual actors in the circular economy. This has addressed a gap in knowledge shown in academic literature and in failed business models. Such an approach is, by design, broad and rather than acting as a conclusive piece of work, should be seen as a foundation and agenda for future research directions. There are many areas of interest.

The first section of this paper outlined the reasons why people own, how feelings of ownership form, and some of the possible outcomes of feelings of ownership including attachment and decisions to keep or discard objects. Additional empirical studies are needed to provoke and test this foundational work. This is particularly true of additional studies which may build on the ownership models, paths and implications of Chapters 2, 3, and 4. There is great scope for several forms of quantitative assessments which would provide robust confidence to the qualitative insights gathered.

The impact of psychological ownership on attachment and decisions to keep or discard an object deserve further attention. Future studies might explore reasons to keep and discard on a large scale and map these back to the motives shown. Of interest here would be

developing a better understanding of the links between the motives of psychological ownership and decisions to keep or discard an object. Identifying product-level attributes relevant to each of the motives in such research would prove insightful. Another study may take a longitudinal approach to understanding the dynamic relationship formed between objects and users. Such a study would quantitatively demonstrate what has been shown through qualitatively in terms of the paths people take in developing feelings of possession. Another possible study could examine the extent to which ownership is felt for products in access-based consumption and how design can be used to enable such feelings. This is a strong direction for design-led research.

The second part of the paper presented the new concept of contaminated interaction. Additional work could assess the extent to which contaminated interaction influences material flows. This is likely only possible in specific contexts but could prove meaningful. For instance, we know that there is some demographic that does not like to drink tap water due to contamination (Rozin et al., 2015) but to what extent does this impact material circulation. A related task of arguably more urgent importance is to identify design strategies to overcome contaminated interaction. Early work in this area suggests that there are a finite number of strategies that can be characterised and presented together as a potential design tool. Such a tool would be useful for assessing contaminated interaction within the circular economy but also types of contaminated interaction that go beyond the scope of circulation such as reducing office noise.

Finally, this work raises several ethics issues that need to be addressed. One basic question that needs answered regards the rights, if any, a person *should* have when temporarily accessing a product. Understanding such rights may be an important step towards the circular economy in which many products will be shared in the future. Another significant question regards information sharing. In a circular economy, what information must companies share? If a product that has been refurbished, for instance, meets the same standards as those that are new, should a company need to tell the consumer that the product has been refurbished? Similarly, do companies need to tell users if they use virgin material or reprocessed material for textiles? Answering these questions is needed when considering contaminated interaction issues.

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