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Will Liam save us?
An analysis of Apple's zero-waste goals and waste networks associated with the MacBook.

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Abstract

As popular awareness of global environmental crises rises, the circular economy model is increasingly heralded as a means to address the environmental impact of traditional extractive economies. Technology provider Apple has been among high-profile corporations quick to adopt a circular model, announcing their plans to both end mining and become zero-waste. In this thesis, I analyse Apple's zero-waste plans using my own notebook as a case study. A discourse analysis of the company's *2017 Environmental Responsibility Report* reveals that the zero-waste approach is (at least in part) a marketing strategy. It works to increase Apple's power and consumer base. The zero-waste strategy is presented as distinct from their social responsibility, echoing the way that waste is conceptualised within the circular economy. Both Apple's zero-waste plan and the circular economy rely heavily on technological innovation to offer solutions to waste. Waste is understood as something distinct from, and entirely controllable by, human intention.

Individual case studies of my notebooks aluminium casing and hard disk drive demonstrate that vast waste networks of human and nonhuman actors enable Apple to function as they do, and are in fact integral to any economy organised around the pursuit of profit. Within this context, attempts to circumvent the worst harms associated with the extraction, production, consumption, and disposal contexts of ICT equipment will end up reinscribing or reinforcing wasteful practices. Through an auto-ethnographic description of dealing with the notebooks possibly failing battery, I argue that understanding ourselves as separate from waste networks (as zero-waste discourses encourage us to do) similarly forecloses the possibility of disrupting the most negative impacts of waste. Repair tentatively emerges as one way of destabilising the power of large corporations that benefit from capital such as Apple. Ultimately, the case studies presented here raise serious doubts about both Apple's zero-waste strategy and the circular economy in general.

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Contents

Introduction

Apple's zero-waste plan

I often tell people that my notebook is older than my school-aged daughter. It is an Apple Macbook Pro, given to me for my birthday in 2012. For the most, I think about the notebook itself very little. It is merely a means to an end. My undergraduate media studies focused almost exclusively on the ways media content and the attendant political economy shapes our lives. For me, my studies of the media offered a theoretical way to engage with the structural causes of issues of inequality, colonialism, environmental harm, and climate change. Until I entered post-graduate study it never occurred to me that the notebook upon which I relied was itself so literally involved in unequal, colonialist webs of power. The media industry as far as I was concerned was something I participated in virtually, my notebook merely a conduit.

Current formations of capital increasingly rely on subjectivity as a site for the production and reproduction of power and value (Bueno, 2017, p. 7). Labour, when carried out in the West at the very least, is ever-more immaterial; concerned with tasks requiring cognitive, rather than physical, capacity. These changes have been both afforded and influenced by networked information and communication technologies (ICT). The material nature of the media is in part obscured by popular narratives and academic work alike that concentrate on significant changes to the way we consume and produce information, and how these changes have impacted society at large. These changes have variously been theorised as the information society, the network society, the attention economy, and cognitive capital. Nonetheless, media is inescapably material. The material presence of media technologies means that mobile phones, computers, and televisions far exceed the role of 'medium' and do more than channel information. Their physicality influences society vis-à-vis influencing the nature of the representations they disseminate. This capacity to shape does not cease when technologies are discarded. The large and increasingly public issue of electronic waste (e-waste) attests to this.

Within the realm of public policy, e-waste is defined as "all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use" (Baldé et al, 2017, p. 11). In 2016, almost 45 million metric tonnes of e-waste was generated globally, and only 20 percent of that was recycled appropriately (Baldé et al, 2017, p. 2). Exactly what happens to the rest of the waste is unclear. There is little regulation in regard to how e-waste is collected at a national level. Globally, the Basel Convention officially prohibits the international transport of e-waste. Nonetheless, transboundary export still occurs both legally and illegally (Baldé et al, 2017, p. 50). E-waste, when not correctly

handled, presents a serious risk to both people and environment. Practices such as burning e-waste to liberate precious metals release a host of harmful substances into the atmosphere, and negatively affects human health (UNEP, n.d., para. 3). When illegally dumped, heavy metals contained in e-waste such as lead and mercury leach and contaminate groundwater and surrounding soil (ibid.).

Similarly, as Sy Taffel notes, the production of microelectronics generates its own set of ethical issues such as

> …the usage of Congolese conflict derived tantalum in microelectronics devices, the working conditions in manufacturing complexes where hardware is assembled, the rapidly rising energy costs required to manufacture and power digital infrastructure… (2012, p.1).

Taffel's point highlights that whilst media technologies introduce new challenges and opportunities, they also reinscribe and reinforce older formations of capital. Producing information technologies relies heavily on extraction, energy, and the ability to exploit the developing world.

Public knowledge of this is increasing thanks to the abilities afforded by media technologies. As a result, providers of digital technologies like Apple have been the focus of sustained awareness raising. 'Name and shame' campaigns from organisations such as Greenpeace and The Basel Action Network have drawn attention to the harm associated with e-waste. In response, Apple have taken initiatives to improve the deleterious environmental and social impact of their products. Creating more energy efficient products and facilities to address climate change, enhancing the conservation of "precious resources", and the development of safe process and product have been identified as key areas in which they can address these issues (Apple, 2017, p. 3). The company claim to be eradicating their carbon foot print during the production process and at data farms they use, designing products that require low energy consumption, and improving their use of renewable resources (p. 5, 17, 20). Additionally, Apple claim to have a supplier code of conduct for all of their partners, which they purport is reducing poor working conditions (Apple, 2017a, p. 3). Finally, Apple have developed and continue to extend responsible sourcing methods to address conflict minerals (2017a, p. 2).

In late 2016, Apple introduced 'Liam' (Liberate iPhone Auto-disassembly Machine). Liam is a recycling robot designed to efficiently take apart iPhones for reuse (Rujanavech et al., 2016, p. 3). In 2018, 'Daisy' was introduced as an 'even more efficient' Liam. The promotional material surrounding the release of the robots emphasises that they are examples

of Apple's commitment to using innovation to reduce their environmental impact (Apple, 2018, para. 1). Liam and Daisy's robotic nature connotes optimisation, constructing Apple's recycling programme as technologically advanced and superior to the inefficiency of conventional recycling. Their anthropomorphised nature imbues the technology with a sense of familiarity, counteracting potential discomfort associated with automated machines. The robots are a key part of Apple's pledge to be zero-waste.

The company's approach in this regard is significant, as it dovetails with an economic approach referred to as the 'circular' economy, which is purported to address the unsustainability of capitalism. As with e-waste, networked digital technologies have played an important part in contemporary efforts aimed at disseminating knowledge about, and organising against, such unsustainability. A circular economy advocates for cycling materials through a closed loop of use and reuse in order to attract maximum value from them whilst lessening the impact on the environment (Murray, Skene, and Haynes, 2015, p. 371). The model is associated with the idea of being zero-waste, where the by-product of one process is an input into another. Along with renewable energy sources, digital technologies play a crucial part in the circular economy. They afford a shift in the consumer experience to one involving convenient buy back schemes, a focus on the supply of services, and increased trade between consumers (Lacy and Rutqvist, 2016, p. xviii). This experience is intended as anathema to the environmentally destructive traditional capitalist economies of single use and landfill disposal. Beyond the consumer perspective, circular economies purportedly eliminate the need for any trade-off between short term economic gain and long term environmental consequence (Murray, Skene, and Haynes, 2015, p. 371; Lacy and Rutqvist, 2016, p. xviii).

The circular economy model is still a capitalist model. Simões and Sebastiani argue that in light of recent economic downturns, "sustainability has emerged as a relevant route for both political systems and organisations" (2017, p. 423). This is the context in which Apple have publicly adopted 'zero-waste' thinking, and are moving to adopt closed loop supply chains consistent with the circular economy approach. For Apple, this means 're-valuing' products at the end of their lives, and considering used electronics a valuable resource that can be harnessed with the right application of initiative and technology. This commitment to zero-waste, in particular, interests me. Given the ways in which media technologies are implicated both with movements to make changes to exploitative, extractive capitalist practices and a part of upholding such economies, Apple's zero-waste thinking requires closer analysis. To do this, I search for waste specific to my notebook, as a way to evaluate whether zero-waste as an

approach really is a way to ameliorate the worst of capitalist excess evidenced by the issues with e-waste.

Research Questions

1. Where is there waste, visible or invisible, as I follow my notebook through its processes of production, use, and disposal?
2. Is zero-waste an effective strategy for ameliorating the most harmful impacts of the waste associated with the notebook, in all of its forms?

Thesis Outline

In this thesis, I set out to elucidate exactly where waste has arisen in relation to my notebook. Given that the notebook contains "hundreds of parts, including microchips, the hard drive, the battery pack, the LCD, circuit boards, resistors, capacitors, wires, and even the pieces of metal and plastic that make up the casing", case studies of particular components have been employed (Tweney, 2007, p. 88). The aluminium casing, hard disk drive (HDD), and batteries have been selected for this purpose. In order to further explore Apple's zero-waste strategy, the Apple *2017 Environmental Responsibility Report (ERR)* is used as a case study.

In chapter one, I situate my study within a body of literature that relates to waste as I formulate a working definition of 'waste'. I argue that e-waste needs to be understood as something more than just discarded devices, and that waste can be conceptualised as a relational effect. In chapter two, the theoretical underpinning of the thesis, actor-network-theory (ANT), is introduced as the approach best suited to searching for waste as a relational effect. ANT itself is set of "material-semiotic tools, sensibilities and methods of analysis" that treat and posit all phenomenon as arising within webs of relation (Law, 2002, p. 2). It enables me to answer the research question through the production of a map of where waste has arisen. Further, the ANT strategy fosters a rich understanding of the way companies like Apple create waste as a way to increase their power, as well as how scientific and technological discourses like 'zero-waste' act to structure and determine material processes. Understanding power as emergent as encouraged by the ANT paradigm lends itself well to an examination of where power can best be circumvented. In chapter three, the methodology and methods used in the study are introduced. I argue for a symmetrical approach, that looks to both human and non-human actors when seeking to understand the causes of particular effects. This does not mean that power will be distributed equally amongst these actors. Symmetry means that a hierarchy is not presumed. Human and non-human actors need to be followed in order to understand a particular effect.

In chapter four, I discuss Apple's *ERR*. I argue that the report represents specific knowledge about waste which strengthens Apple's position. The representation of waste offered in the report is not entirely deterministic, but as a discourse it participates in the process of structuring associations in the Apple network. This chapter demonstrates that zero-waste is at least in part a marketing strategy, designed to increase demand. Addressing research question two, I suggest that this raises questions as to whether zero-waste can be effective as a strategy to ameliorate the harmful impacts of waste. In chapter five, I introduce the aluminium casing.

I begin to map waste networks, demonstrating how through black-boxes and immutable mobiles, Apple are able to exercise their power despite differences in geographic position and time. I argue that rather than eliminate waste networks, Apple's current recycling infrastructure creates new waste networks. These waste networks are in fact an integral part of capitalism, a point reinforced by attempts made by other actors to circumvent waste that have not been entirely successful.

In chapter six, the HDD is introduced, and I demonstrate how design decisions contribute to waste networks. The waste networks represented here reflect different power strategies and occur in different geographic locations, but nonetheless have many similarities with those mapped in chapter five. I build on the argument from chapter five to demonstrate that as researchers and activists come together with those affected by the network of waste to make waste visible, a shared experience is created. This shared experience presents a risk of reinforcing, rather than reassembling, harmful waste associations. This insight troubles the ontological premise of the zero-waste and circular economies. Finally, in chapter seven I offer an auto-ethnographic account of my experience with my malfunctioning notebook battery to map waste networks associated with both lithium-ion batteries and consumer disposal of ICT equipment. I show that waste reduction theories focused on consumer change are destined to fail, since individual intention must always be understood as constituted by an actor-network comprising powerful extra-somatic actors like obsolescence. Ultimately, zero-waste relies on understanding the self as ontologically distinct from waste. The consequence of this is the foreclosure of possibility of actually ameliorating the worst of the waste effects. Through an exploration of the concept of care, repair is foregrounded as a practical step consumers can take to exercise their responsibility to the waste network they are implicated within as ICT users. I conclude the thesis by suggesting that the waste networks that have been mapped in this thesis raise serious doubts about Apple's zero-waste strategy, but more broadly about the circular economy in general. I argue that at the very least political action must be taken to broaden the scope of the circular economy to take the social context of waste into account.

Chapter one
What is waste? A literature review.

This chapter aims to provide an introduction to how e-waste, and waste more broadly, has been conceptualised within academic literature, before situating my own study within this body. Within media studies, e-waste has been addressed through studies that work within a new materialist theoretical orientation that seeks to position the media text within a broader temporal, geological, and geopolitical milieu. Much of this work has been done within two key bodies of literature, namely 'media ecology' and 'media archaeology'. These trends are closely related to broader studies of the material processes of the text undertaken within critical infrastructure studies and post-humanist studies, not considered in depth here for reasons of brevity. Outside of media studies, e-waste has been studied by anthropologists, human geographers, sociology, and cultural studies researchers *inter alia*. As part of a broader body of literature focused on waste, such scholarship has been undertaken within the perspective of materialism (both historic and new), as well as within the constructivist and positivist traditions. In this chapter, I introduce symbolic and materialist ways of thinking about e-waste and waste more broadly.

To address the research question and elucidate where waste arises in relation to my notebook, I first must define the parameters of what I am looking for. What, in other words, is waste? Here I follow Jennifer Gabrys (2011) to define e-waste more broadly than the 'official' definition of e-waste given in the preceding section. Instead, the waste I am searching for is the waste that arises as the materials for the notebook are extracted and the waste that arises as the notebook is produced in addition to the waste that will result when the device is discarded. The term waste has been used so as to prevent confusion with the narrower definition of e-waste. Ultimately, I draw upon the literature introduced here to define waste as a relational phenomenon characterised by harm, idleness, surplus, depletion, carelessness, and degradation.

Political economies of waste

This section introduces some key critical approaches that consider the political economy of waste, approaches that foreground the centrality of the relations of production in both understanding why waste and/or 'zero-waste' discourses have arisen. Francisco Valenzuela and Steffen Böhm use a combination of Marxism and Lacanian psychoanalysis to

understand how Apple's zero-waste strategy creates a feeling of lack in consumers, which drives continuing consumption (2017, p. 23). Further, they argue that the zero-waste marketing strategy used by Apple de-politicizes the issue of e-waste (2017, p. 26). In other words, a politics based on environmental concern loses its potency when incorporated into discourses of sustainability. When waste is 'zero', it is made invisible through the rhetoric of its complete elimination. Further highlighting the significance of the symbolic classification of waste, Jennifer Gabrys describes how there are two discourses that surround waste - one of abundance, and one of complete elimination. Waste, electronic or not, is often described as spectacularly abundant, catastrophic, or a crisis. Alternate representations of waste, on the other hand, rest on either completely eliminating it, by making waste positive, productive, and profitable (as Apple frame their environmental goals) (2011, p. 149). Each of these possibilities completely forecloses meaningful action. Valenzuela and Böhm's approach to waste elucidates the complexities of the relationship between subjectivity and waste. In contrast, approaches to waste rooted within the historical materialist strand of Marxism foreground the ways in which waste is inextricably enmeshed with relations of production.

Whilst not specific to waste, John Bellamy Foster has contributed significantly to applying the theoretical toolbox of historical materialism to the study of the environment. Foster argues that the relations of production that typify capitalism have led to an 'ecological rift.' He builds on Marx's concept of the metabolic rift, which noted that natural human relations to nature have been "torn asunder" by the conditions of production (2010, p. 204). Understanding crises such as waste, and the impact of waste on the environment, can only be done by considering its historical specificity (2010, p. 27). 'Waste,' and all knowledge about waste, arises within conditions specific to a particular society. Foster's work is one of the most significant applications of a Marxist approach to environmental issues. Brett Caraway has built on the work of Foster to conduct an analysis of the Apple *2016 Environmental Responsibility Report*, ultimately arguing that Apple misrepresent "its products and policies as ecologically responsible" (2017, p. 499). He notes that it is inherent within capitalism that even if greater resource efficiency can be achieved (as is at the crux of the Apple and circular economy approach), a crisis of production will still result as capital seeks out additional investment outlet to the detriment of the environment (2017, p. 500).

In relation to this study, Foster and Caraway's work is most insightful, as it foregrounds the critique of green capitalism, and the paradoxes inherent in these 'sustainable' approaches.

The historical approach, for example, highlights the way that the capitalist logic of supply and demand have in the past contradicted attempts to use resources more efficiently. They notes that this calls into question the notion that renewable energies will displace fossil fuels, instead potentially creating conditions in which the demand for fossil fuels increases (2010, p. 190). Empirically, Foster and Caraway's work is supported by Makov and Vivanco who found that on average the additional demand for smartphones created by the increased efficiency and cost-savings afforded by a circular economy means that on average one third of the savings in emissions are lost (2018, p. 8). These approaches are employed here as exceptionally well suited to the critique of zero-waste as an ideology, offering arguments as to how these discourses entrench capitalist modes of organisation. Foster, for example, foregrounds the notion that technology is socially and historically constructed. Approaches constructing technology as the solution employed by Apple and circular economy proponents ignore the conditions under which the technology is produced (Foster, 2010, p. 427). What is missing from analyses like Foster and Caraway's, however, is a recognition that technology does introduce significant changes of scale and pace into human affairs.

Also drawing on Marxist perspectives, in *Greening the Media* Richard Maxwell and Toby Miller take a political economy approach to analysing the environmental impact of the media. Their work demonstrates that the fetishisation of technologies, and the way that human characteristics of modernity, taste, beauty, and efficiency are inscribed into ICT equipment, obscures the chasm between the consumption and production contexts of such devices (2012, p. 7, 23). Using supply chain research, they explore the global nature of the production and dismantling of media technologies, arguing that greater transparency in regard to working conditions is needed in order to bring about "structural change" (2012, p. 8). Maxell and Miller's work locates class struggle firmly within the environment. They advocate for extending the demand for basic rights to *all* organisms, human or otherwise (2012, p. 158). Maxwell and Millers contributes significantly to developing a blueprint for what being an environmentally ethical citizen located within new, green formation of governance might look like. Yet in such a conception, the environment is treated exactly the same as the human. Whilst it is afforded the same rights, it is not recognised as having the same capacity to alter human and non-human affairs. In the next section, I explore approaches to waste that attempt to understand the ways that waste is represented and categorised, before moving to build a more radical position, which differs from Maxwell and Miller in that it attributes agency to material constructions such as waste.

Representations of waste

In this section, I outline approaches to waste (electronic and otherwise) that have been carried out in what can be conceptualised as a constructivist orientation. These studies foreground the ways that 'waste' is waste insofar as particular materials have been symbolically and semiotically constructed as such. Such an approach highlights that popular cultural representations of waste are an important way in which the media-viewing public comes to understand what waste is and who is responsible for it. Linus Andersson has demonstrated that e-waste imagery is often presented as 'toxically sublime.' This leads to its perception as something that is urgent, yet separate from modern life and occurring 'over there' (2015, p. 274). Heather Sullivan has argued that dirt in the broadest sense (including soil as well as things often associated with waste like grime and toxic sludge) tends to be omitted from media representations of 'greenness' (2012, p. 515). She argues that the ontological consequence of this representation is an understanding of the environment as divided into two spheres, 'clean and green' nature on one side and the dirty human sphere (ibid.).

The symbolic function of waste has most significantly been theorised by Michael Thompson and Mary Douglas. Thompson understands waste as 'rubbish'. Rubbish, for Thompson, is not synonymous to how we use the words rubbish, trash, waste, or garbage. Instead, rubbish is a social category that things move in and out of, a placeholder between transience and durability (1979, p. 9). Objects become rubbish through practices of disposal. Similarly, the can be transformed from rubbish through practices such as finding, displaying, transforming, and re-using (Parsons, 2007, p. 391). Thompson's theory focused on the practices of human actors, and the way in which the worth of an object determines whether or not it passes between categories (Hawkins, 2006, p. 79). Taking a different approach to Thompson, anthropologist Mary Douglas has also contributed significantly to the examination the symbolic function of waste. Douglas argues that waste is the "by-product" of a way of ordering society which defines by way of rejecting what it is not (1966, p. 36). In this conception waste arises as a way to affirm what is human, and part of 'us', and what is not.

Jonathan Sterne approaches the topic of an electronic kind of waste by following Michael Thompson to note that "obsolescence and durability are socially imposed categories" (2007, pp. 22-3). Thinking about the old personal electronics that end up as waste, Sterne argues that the computer undergoes a "symbolic journey" from "new, to useful, to obsolete, to unused, to trash". For Sterne, as the old item passes through these stages, its function and

meaning shift (2007, p. 24). Sterne approaches the issue of waste through a consideration of how the personal electronic becomes waste, exploring the transformation of the item during the end-user stage. Sterne suggests that the user often uses the machine past when it has "lost value" until forced into upgrading, due to either the machines inability to perform a function as needed or mechanical breakdown (2007, p. 24). There is then another period in which the user continues to believe that the item may have some value, "likely resulting from a retained sense of the initial price of the item" (Sterne, 2007, p. 25).

These approaches all add to a rich analysis of the way that representations matter. We come to understand the material world through the media, as Sullivan and Andersson point out. Symbolic understandings of waste inform the actions taken in response to it. How waste, and the environment more broadly, are symbolically constructed matters. Yet this is not the whole story. Waste, as a material cannot be adequately understood as a solely passive receptacle of human meaning. Forgotten, unwanted materials have their own capacity to influence things. Material transformations can be, as Sterne notes, the product of human intention, as is explored further in chapter seven. Yet they also occur independently of human intention. In regard to e-waste in particular, these transformations play an important role in their symbolic journey.

Geographers Josh Lepawsky and Charles Mather's approach, for example, explain the material transformations of e-waste in a way that decentres the anthropocentric focus on transformations. They argue that drawing clear, symbolic distinctions in the stages of a commodities life (raw material, finished good, waste, and so on) is impossible (2011, pp. 242-3). Instead, electronic devices are best understood as undergoing symbolic transitions into and out of being classified as 'waste', and that these transitions are accompanied by both material transformations and geographic movement. Thus, they argue that e-waste ought to best be studied as an indeterminable site, with transformations that cannot be known in advance, but instead emerge when human practices and representations interact with material properties and affordances (Lepawsky, 2011, p. 242). Lepawsky and Mather's work proves a useful way to think about waste, insofar as it acknowledges the ways that materials play a role in the human categorisations and attendant interventions. In acknowledging this, they are operating within a new materialist theoretical framework. Before extensively detailing the history of this scholarly tradition and its uptake within media studies in the next chapter, in the next section I overview different approaches to waste and e-waste that have been undertaken within this tradition.

New materialist approaches to waste

The new materialist approach to waste considers its material form and properties alongside the symbolic, subjective, productive, and geographic conceptualisations of waste offered above. Instead of being considered an inert receptacle of meaning, waste is considered as agential. In *The Ethics of Waste*, Gay Hawkins provides a useful introduction to the continuities and differences between the aforementioned approaches and the new materialist approach. Waste, she begins, *is* a culturally constituted, symbolic order. Yet this is not so much a rigid or fixed category of things, but instead is a set of relations where values of order become embedded in material forms (2006, p. 2). At the same time, Hawkins argues that the human waste relationship is mutually constitutive. The human sense of being an 'I' or an 'us' emerges in the open-ended relationships that see 'waste' emerge as a category of all that we are not. In other words, we make waste, and waste makes us (ibid.). An important consequence of theoretically framing waste solely as 'the other' is that as humans we develop a "fantasy of self-sovereignty and ontological separateness" (2006, p. 80). We see ourselves as separate and distinct from waste. A new materialist approach to waste posits that this is not the case. Instead, Hawkins argues that to understand and address the crisis of waste, it needs to be understood as an entity that is continuously transforming, and that has some degree of agency within these transformations (2006, p. 9). Waste participates in its classification as waste. As Hawkins, writing with Jennifer Gabrys and Mike Michael, argues in regard to plastic waste, waste has a degree of material recalcitrance, as it refuses to go away despite human effort and social classification (2013, p. 3).

Similarly, anthropologist Peter Little's uses political ecology as an approach to analyse the relationships between nature and society, political economy, environmental change highlighted by the aftermath of IBM computer production in Endicott, New York (Little, 2014, p. 20). The political ecology approach to waste foregrounds and politicises the relationships between the economic, the social, and the environment. Endicott is the site of a toxic plume, the result of decades of volatile organic compounds and other toxic chemicals leaching. Little's study uses ethnography to understand the experiences of citizens living with the plume, and with the mitigation strategies employed to deal with the plume (Little, 2014, p. 184). Little's study is significant in that he argues that a degree of subjectivity needs to be afforded to the mitigation strategies in place, and the way they have had the power to immensely shape the affected community's lives. For Little, political ecology opened up a theoretical space to explore the ways that citizens and communities living in the aftermath of environmental crises "engage with (and often resist) state organisation and control of both the environment and the

economy, both ecology and capital" (2014, p. 185). Politicising ecological studies as Little has done in this way resonates with a current of media studies that addresses the media's materiality, known as media ecologies.

A novel approach to e-waste within the new materialist tradition uses an auto-ethnographic approach. Alison Stowell and Samantha Warren used their own experience of participating in e-waste recycling at a safe' recycling plant in Britain to explore how the institutional status quo in regard to e-waste is maintained through micro-level interactions (2018, p. 787). They focus in particular on how physical pain is made sense of socially, becoming understood as something other than pain, something that just is. They argue that it is in these interactions that institutional conditions are maintained (2018, p. 804). Thus, their approach is necessarily one that resonates with the framework to employed here, in that boundaries between social and material, biological and cultural are dissolved to consider how human and non-human actors work together (2018, p. 786, 805). In contrast, Åsa Ståhl, Kristina Lindström and Eric Snodgrass studied the relational quality of obsolescence by re-activating old cell-phones they collected from a variety of different people (2014, p.1). Two of the authors weaved the data into an SMS story, *P.S. Sorry if I woke you*. The third author then used auto-ethnographic method to detail their responses to the story (ibid.). The project highlighted the dually sensitive nature of dealing with e-waste that arises from the fact it contains both potentially valuable metals and personal information (Ståhl, Lindström, and Snodgrass, 2014, p. 4). Ståhl, Lindström, and Snodgrass have expanded the understanding of obsolescence from imposed to relational, arising in interaction between devices, technology providers, and consumers (Ståhl, Lindström, and Snodgrass, 2014, p. 10). Further, their project is an example of a novel approach to attending to the ways that technological devices are mutually shaping and being shaped by wider social forces. Counter-intuitively, both of these auto-ethnographic approaches each find a way to attend to both the material and symbolic reality of e-waste

The materiality of the media

Within media studies, there are four key bodies of literature that address the material presence of the media: critical infrastructure studies, post-humanism, media ecologies, and media archaeologies. Critical infrastructure studies consider media infrastructures, that is, the network cables, the data centres, the satellites and so on. The field draws attention "to media infrastructures entanglements with environmental and geopolitical conditions, from the moment of installation through their residual uses" (Parks and Starosielski, 2015, p. 4). Most importantly for this project, critical infrastructure studies raises questions about the extent to

which extending media infrastructures into developing countries as a way to address a digital divide is addressing a desire in such countries for access to networked information technologies, or addressing the desires of "Western humanitarianism and/or digital capital" (Parks, 2015, p. 132).

Post-humanism is a body of scholarship that aims to not blur the boundaries between the human and the surrounding environment, but to understand how these boundaries have been ideologically constructed in the first place (Barad, 2011, p. 123). Within media studies, this approach has often highlighted the way that human cognitive process are shaped by digital technologies (e.g. N. Katherine Hayles' work on attention), and the ways in which media technologies have become, as McLuhan (1994) has argued, extensions of (hu)man. Particularly relevant for this project is Jussi Parikka's observation that the harmful aluminium dust breathed by Chinese workers polishing iPads troubles any easy boundary (skin) we apply to ourselves, which "force(s) us to rethink the boundaries of individuality as well as space" (2015, p. 88). Here, dust, as Parikka points out, is a useful tool with which to "understand the significance of the nearly imperceptible nonhuman element" (2015, p. 102). Parikka's observation can be understood in relation to Lepawsky and Mather's work highlighted earlier as demonstrating that foregrounding relationships, as opposed to using categories with rigid boundaries, is a useful way to understand waste. One way of conceptualizing relational natures within media studies has been through media ecologies.

Media ecologies imagines media as a system that comprises media and technologies, subjects, social and political forces, and so on (Scolari, 2012, p. 214). It is worth noting, that this conception differs from the definition of media ecology often employed in North America, which instead focuses on descriptions of the media environment. Very broadly defined, the definition I highlight here as relevant to this work, refers to the relational study of how human and non-humans relate to, interact with, and transfer energy to each other within complex networks (Taffel, 2013, p. 233). Scholarship on the materiality of the media taking a media ecology approach aims to map the ways that "materials and energy (flow) within media systems comprising humans and non-humans" (Taffel, 2016, p. 124). Professor Sean Cubitt has notably used the ecological approach to study the materiality of the media, arguing that "ecological thinking places the emphasis on the priority of systems over nodes" (p. 137). Cubitt describes how in an ecology elements are connected, and mediate one another (2016, p. 4). "Mediation," he argues, "precedes separation" (ibid.). Yet as power flows through these mediations we have come to see the world as separate. This has important consequences, in the form of environmental and social oppression and exploitation. The media text mediates particular

technologies, politics, molecules, energy, and so on (ibid.). Through the media text we have learned to see the world as separate, but Cubitt argues that it is through the media text we can learn to see the world differently.

Within the media ecologies tradition, Sy Taffel has explored harms to humans posed by media infrastructures and practices. Taffel shows the ways in which resources and materials move through systems and spaces, and the "deleterious social and environmental impacts" that this has on human and non-human actors (2016, p. 121). Undertaking an ecological study involves mapping "cycles, loops, and flows" rather than producing a linear tale of extraction, production, use, disposal (2016, p. 125). Particular moments can be selected in order to highlight particular conditions and a set of "embodied and geopolitical relations," making visible that which has been made *invisible*, whether by zero-waste discourses or the simple fact of the spatial separation of producing bodies and consuming bodies (2016, p. 125). Whilst my study does not use the media ecologies as an overarching theoretical framework (a point explained further in the next chapter), its influence can be found throughout. Most notably, thinking within the media ecology tradition is reflected in the way that particular moments have been foregrounded in order to highlight a set of relationships made invisible.

The media 'archaeology' approach, most notably employed by Parikka, has been a significant way in which the materiality of the media has been addressed. Media archaeologies extends Foucault's archaeological method to the media. It is concerned with the not only the histories of the media, but what happens inside media machines (Parikka, 2013, p. 86). Drawing heavily on the work of German scholar Friedrich Kittler, the approach focuses on the material conditions which make the media possible. Media archaeology aims to disrupt the notion of the history of media as a linear process, and instead "sees media cultures as sedimented and layered, a fold of time and materiality where the past might suddenly be discovered anew, and the new technologies grow obsolete increasingly fast" (Parikka, 2013, p. 3). Studies of media 'waste' within this perspective take the "textual, visual, and auditory archives" and the old and forgotten media devices, artifacts, and technologies as starting point (Huhtamo and Parikka, 2011, p. 3). These are considered sites where material culture can be understood, and forgotten, obscured, and repressed discourses made visible once again (ibid.).

Taking a similar focus on the history of the media, James Allen-Robinson fuses new materialism with historic enquiry in order to recognise the specific "software, hardware, materials, mechanics and form" of media objects in order to "resituate" new media within systems of power and "liberate its tangible material presence from discourses of weightlessness" (2017, p. 457). Allen-Robinson offers an outline of the composition and

function of the HDD, discussing the ways in which such a descent into "material foundations of digital objects" makes visible particular characteristics and material realities (2017, p. 462). Allen-Robinson makes clear that the materiality, historical continuity and significance of the HDD challenges notions of new media representing a clean 'break' with the old (2017, p. 468). Ultimately, Allen-Robinson argues that material realities are crucial in order to understand digital media - "how it persists, how it acts, and is acted upon" (ibid).

Jennifer Gabrys approaches the waste generated by the media from a natural history perspective in her book *Digital Rubbish*. Gabrys' argument and method in relation to articulating electronic forms of waste is surmised as such

> "... there are multiple ways in which electronics generate waste. Rather than imagine the simple elimination of this waste, I have traced these residues (of waste) from the fossils of manufacture to the sites of technological imagining. By working through these remainders, I have attempted to demonstrate that waste is more than a heap of defunct objects; it is also a mixture of flickering and mutable relations" (2011, p. 149).

Gabrys' work treats electronic waste as a phenomenon much broader than the digital devices that may end up in landfills (2011, p. vi). For Gabrys, waste is a set of dynamic relationships. Waste is never static, but always in flux (Gabrys, 2011, p. 12). Gabrys highlights the temporal paradox presented by e-waste, which operates on two timelines: the sped-up process of obsolescence, and the longer processes of "enduring chemical-material conditions" (2011, p. 142). This treatment of e-waste greatly informs my own. In the next section, I build upon Gabrys' definition to demonstrate exactly how I will define waste in this study.

What is waste?

The waste Gabrys introduces us to is a particularly electronic kind of waste, which includes the waste that comprises the "dead" devices that have channelled the digital revolution (2011, p. 2). She points out that these devices, as the electronics industry grows, bolstered by the pervasiveness of electronics in everyday life and obsolescence - both planned and perceived, comprise an ever-increasing portion of the waste stream (2011, p. 2). Within the literature, such a specifically electronic kind of waste has been defined as having very particular qualities. Namely, it is considered notoriously difficult to manage, recycled only in very small quantities, and is often stockpiled (ibid.). Triantou and Taramtouli note that about 20 percent of the weight by volume of Waste Electrical and Electronic Equipment (WEEE) is polymer

(2012, p. 1). Bazargan, Lam, and McKay note that contained within e-waste are a variety of "organic substances and metals" (2012, p. 40). The organic substances are most often added as fire retardants, and the heavy metals include cadmium, mercury, lead, chromium (ibid). Smaller devices in recent years do not correlate to less waste, since the "effect has been counter-balanced by increased sales, particularly in developing countries" (ibid.). I follow Gabrys to argue that this type of waste only describes a small portion of waste that relates to electronics (2011, p. 12). The waste generated by the production of electronic devices must also be considered as electronic waste.

As Hawkins, Thompson, Douglas all highlight in different ways, waste is a category used for ordering, whether as a measure of value, or a measure of what we are not. Taffel's study introduced above in particular highlights the way that the consequences, in the form of negative human and environmental effects, of being considered less valuable are evident right through the process of extracting materials for, producing, using, recycling and disposing of electronic devices. This insight not only emphasises that a full understanding of e-waste must take into account more than just discarded devices, but also emphasises that that which is not valued is often at times human. This perspective is reinforced by Cubitt, who argues that waste is not just an "unfortunate by product of consumerism," and is this more than just physical traces of the physicality of digital media (2015, p. 141). E-waste qua Cubitt necessarily includes "populations excluded from centres of capital" (2015, p. 141). These are the populations that are surplus to the requirements of production for a networked, circular economy. Being excluded in this way is akin to being defined as separate from, irrevocably different from 'us' as a Western society.

Cubitt's work, then, supports the position I take in this study that any critical examination of waste must consider that humans can be waste. Like Cubitt, sociologist Zygman Bauman argues that waste is the outcome of all production, and that capital's waste is never solely material but also human. Economic progress since the beginning of modernity has never failed to leave some behind (Baumann, 2004, p. 15). For Bauman, the creation of anything new in our society involves taking something and fashioning off what is not needed. This surplus is his idea of waste. Prosperity and economic growth are crafted by an ever-increasing process of refining, of removing, the people that prove to be unnecessary, in the same way a miner discards rock around her precious mineral (ibid.). 'Waste' humans carry out the hazardous, dirty job of 'recycling' electronics, or are on the peripheries, surplus to the requirements of an

economy that increasingly deals in the production and consumption cognitive commodities (Bauman, 2004, p. 60).

It is worth noting that the use of the term 'human waste' to describe people is contentious. Gillian Wylie, for example, argues that whilst it is clear that many people are severely harmed by a global capitalist system, calling them waste is "determinist and debilitating," depleting such people of agency and further excluding them (2014, p. 57). Put simply, to categorise humans as waste is to construct the human as waste. Michelle Yates, in conceptualising the human-as-waste, argues that "capitalism is a structure that transforms people into waste" (2011, p. 1679). Humans are useful in global capitalist systems insofar as they produce or reproduce, and when they are not productive they become waste. Further, as L. Saraswati explains

> "...because capitalisms main goal is to accumulate capital, it necessarily employs certain ideologies (i.e., gender, race, etc.) and creates a structure that designates certain workers (i.e., migrant workers) as disposable in order to maximize profit" (2017, p. 603).

Ultimately it is these processes of becoming disposable, of being 'used-up' and discarded that I am searching for.

Broadening the definition of waste to include humans is nonetheless exceptionally fraught. Classifying humans as waste has the potential to foster a separation between the researcher and the 'wasted' research subject. Thus, the dichotomy of 'us' and not 'us' is reinforced, potentially reinscribing the classification that originally bred such deleterious consequence. Michelle Yates argues that to prevent being deterministic in this way, the researcher must pay close attention to how people strategize, retain control, and refuse to be silent (2011, p. 57). I concur with Yates. My own strategy goes further, and has to do with the relational aspect of waste highlighted in the literature. As has been shown, Gabrys argues that waste is a set of dynamic relationships. Waste arises from these relationships. No human is waste, but rather their status as 'waste' arises in their interaction with other entities. Insofar as it is a social category, waste describes these relations.

Concluding Thoughts

As has been suggested by the new materialist literature here, however, this set of relationships that compromise waste cannot be explained adequately with recourse only to the social. As Gabrys, Hawkins and Michael point out, that which we classify as waste refuses to

go away, it persists and changes despite classification. Because of this, the symbolic approaches here are inadequate for explaining the complexities of the digital production process pointed out by Taffel, and the material transformations highlighted by Lepawsky and Mather. In the chapters that come, the waste that is introduced is electronic insofar as it is associated with my notebook (an electronic device). As noted above, the term waste is used to prevent confusion with the narrower 'official' definitions of e-waste. This waste is diverse and persistent, including materials that existed long before humans classified them as waste, and will exist long after. These entities may or may not be classified as 'waste' per se, and their status as valuable varies. Finding waste is akin to identifying and describing a set of relationships which are characterised by the fact they result in harm, idleness, surpluses, depletion, carelessness, and degradation. They involve humans and non-humans. Such a definition has been broadly informed by the approaches to waste that have been introduced here. It is primarily new materialist in orientation. At the same time, I take from the political economy approach a deep scepticism of the zero-waste marketing strategy utilised by Apple. Constructionist approaches inform and underpin my work insofar as I note that representation does matter, and human inclusion in a definition of waste needs to be approached cautiously. In the next section, I outline the new materialist orientation more thoroughly, and detail specifically how it will be employed in order to find waste.

Chapter two
Media (and) materiality: A theoretical framework.

In the previous chapter, waste was introduced as a relational phenomenon by way of a review of the literature pertaining to waste. This chapter builds on the previous chapter to introduce waste as a networked phenomenon, as I outline the theoretical orientation of this thesis. As noted, I adopt a new materialist framework. The term 'new materialism' was coined in the 1990s by Manuel DeLanda and Rosi Braidotti (Van der Tuin and Dolphijn, 2012, p. 48). As such, this chapter provides an introduction to new materialism. At the most general level, new materialism challenges the idea that matter is inert, positing instead that matter is agential, possessing the capacity to be both affective and affected (Ellenzweig and Zammito, 2017, p. 7; Parikka, 2010, para. 3). Such a framework, as briefly introduced in the previous chapter, conceptualises waste as relational. As I have begun to demonstrate, the material constitution of waste, the symbolic constitution of waste, in addition to the attendant social, environmental, and economic contexts of waste all act together, and in that relation waste is determined (Law, 2003, p 2).

Within critical scholarship, materialism has most often been associated with Marx's notion of historical materialism or a dialectical materialism, but in recent years the "ontological and epistemological presumptions" of approaches such as structural Marxism have been challenged by post-structuralist ideas, introducing new ways of thinking about materiality (Coole and Frost, 2010, p. 3). Yet, a 'new' materialism does not point to a discrete stage so much as a continuation, another point along a line of theoretical understanding (Parikka, 2010, para. 8). In this chapter I chart this course, and comment on theoretical shifts within media studies. Because of the centrality of Gilles Deleuze and Félix Guattari's work to the development of much new materialist thought, notably the development of the media ecologies, here it is briefly introduced. I introduce other influential bodies of work within new materialism, including feminist science and technology studies. Finally, I introduce ANT as the theory that underpins my thesis. We see that ANT differs from other bodies of new materialist thought as it describes effects as arising from the totality of interactions between nodes in a network. This is contrasted here with the notion of intra-action, which posits that objects do not precede relationships, but rather are constituted in relationships. From the outset, I must note that Bruno Latour, ANTs main proponent, is conflicted as to whether ANT is a theory at all. Insofar as ANT is an analytical framework that encompasses ideas about what power, structure, society, nature and individuals are, it is treated here as such (as will be built

on, the problem arises because ANT rejects any distinction between these elements) (Harrington, 2005, p. 1). Nonetheless, I argue that ANT is well suited here as a framework for addressing the research aims as it enables me to map and analyse relations from which waste results between entities located in vastly different positions in space and time, provides a theoretical language to analyse how qua waste Apple build and sustain their power, and to describe how the scientific knowledge of a circular economy acts to create new societal formations with specific types of waste.

Materialism, Marx, and the media

Given that the very broad gist of the thesis is to explore the relationship between humans, media, and the environment, I begin by looking at how these elements have been conceived of through time. The term materialism when defined very broadly asserts that all that exists is, or can be explained "in relation to" matter (Philips, 2003, para. 1). In other words, material things exist prior to, and independent from, thought (Foster, 2000, p. 2). The work of Karl Marx has significantly developed the concept of materialism. Dialectic materialism stresses both the evolutionary nature of materialism, and the interconnectedness and dynamism of relationships between the social and natural. Historical materialism, a key tenant of Marxism, reworks and extends these principles of dialectic materialism to social life. It posits that the material conditions of a society determine how that society is organized by way of determining the specific conditions of production that society is organized around (Edwards, 2010, p. 284). Marx himself never provided a comprehensive description of nature (Castree, 1994, p. 16). However, he makes the argument for the unity of nature and humanity. Their separation, he notes, is a process particular to capital-labour relations (as cited Elster, 1986, p. 201). Further, he notes that this separation will be overcome by both the social relations of production and matter itself (Maurer, 2006, p. 3). As people carry out the activities of production by participating in nature, they shape it to reflect social processes. As material conditions are altered they shape social processes, eventually leading to people realising the contradictions of their existence (ibid.).

Despite Marx's position, dialectic and historical materialism ultimately were largely taken up in the humanities and social sciences in a way that stressed the separation between human thought and nature- consciousness was often reified as apart from nature (in part as a means against forms of racist, classist, and sexist biological essentialism) (Foster, Clarke, and York, 2010, p. 33). Nature, on the other hand, was conceptualised as bourgeoisie ideology, or

as a blank canvas upon which human ideas were inscribed (see Castree, 1994, p. 6). In other words, nature was considered a social/cultural construction. This tradition tends to be attributed to Georg Lukács', who argued in 1923 that extending the dialectic method to nature was impossible. Lukács argument was predicated on the fact that as a method the dialectic relied on reflexivity in regard to subject-object relations, "the unity of theory and practice, (and) the historical changes in the reality underlying the categories as the root causes of changes in thought…" (as cited Foster, 2010, p. 217). As humans cannot be reflexive toward nature in this way, the method cannot be applied to nature (Foster, 2010, p. 217). Hence, Lukács argument was a significant contributor to a trend for Marxism to be taken up solely as theory of society. Materialist study within this vein continues through the political economy approach to media research, which explores the way the media technologies aid and abet class domination and exploitation, struggle and resistance (Mosco, 2013, p.2).

McLuhan, Kittler, and a turn to the material

In contrast to strands of Marxism which focus on the way that the social determines human experience, two broad currents within media studies cast focus on the non-human elements of the media (Parikka, 2013, p. 63). Although a nationalist division is overly simplistic, loosely these currents have arisen from German and North American media theory (ibid.). Within the North American tradition, Marshall McLuhan developed arguments first presented by Harold Innis. Innis proposed a 'staples thesis' which argues that the natural resources that predominate within a historical period has a key role in determining the power relations of that society (Altman, 2003, p. 232). In other words, the group that controls access to the staple dominates in other realms, in ways that are often unpredictable and unexpected (Stokes, 2013, p. 37). Applying his theory directly to communication, Innis argued in 1950 that through history media has been biased toward either space or time. This specific form that media takes favours particular power regimes (1950, p. 7). McLuhan developed these arguments about the importance of the communicative medium, ultimately arguing that "the medium is the message" (1994, p. 7). He proposed that media technologies influence societal structures (ibid.). His argument has been both widely taken up, and dismissed as technological determinism.

Similarly, for one of the most notable scholars of the German tradition, Friedrich Kittler, the medium is the message. But Kittler rejects McLuhan's notion that media are human extensions. Further, he argues that the notion that we can understand media is impossible, since it is the media that "control all understanding and its illusions" (1999, p. xl). The media, that

is, determine what and how we know (1999, p. xli). Like Foucault, Kittler is concerned with how meaning is constructed through discourse (Gane and Hansen-Magnusson, 2006, p. 316). Kittler argues that not all information is discourse, and in fact much information exists outside discourse. His work emphasises the role of material entities and processes in examining how the media shapes society. This insight contributes to my own work an understanding of discourse as existing within wider information networks. Kittler's work is a good example of what Cubitt has described as the "neo-materialist turn" in media studies, popularised by theorists like Parikka and Gabrys (Cubitt, 2015a, para. 3).

This new materialist approach to the media reflects a wider school of theory that attempts to engage with matter without losing the insights borne from constructivist theory (Alaimo and Hekman, 2008, p. 5). Thus, as noted at the end of chapter one, in this study the materiality of the notebook, the political economy of its production, and my experience as user are considered together. New materialist scholarship is a lens in which to demonstrate how human factors such as discourse co-create reality along with technologies, nature, and non-humans (ibid.). As a theoretical framework, it posits that matter is not entirely inert and uniform, does not adhere to a set of fixed and knowable laws, and is not solely socially constructed (Sencindiver, 2017, para. 1). Positivist and constructivist ontologies are unable to respond to the complexities arising from the environmental crises of the Anthropocene. The understandings of agency and causation within such paradigms have garnered ways of thinking, acting, and organising unequipped to meet such challenges (Coole and Frost, 2010, p. 6). What follows is an overview of key thinkers and core ideas within new materialism designed to orientate this thesis by way of asking what it means to know waste.

Assemblages and Networks

Quite central to the progression into a new materialism has been the work of Deleuze and Guattari (Van Wert, 2015, para. 2). Deleuze and Guattari re-conceptualised the relationship between humans and nature from one in which human subjects act within a world where they co-exist with the repetitive actions of "dead matter" to one in which humans and nature exist within a "plane of immanence" where "unformed elements" enter into assemblages (Coole and Frost, 2010, p. 8; Deleuze and Guattari, 1987, p. 255). The concept of the assemblage is significant here, and comes from the French *agencement*, a verb meaning to piece together, to lay out, to arrange (Nail, 2017, p. 22). Assemblages in this sense are not just collections of things, but a specific kind of arrangement of things (Nail, 2017, p. 24). Everything is part of an assemblage, and the arrangement of assemblages are in a state of flux. Using the analogy of a

book, Deleuze and Guattari argue that while the assemblage may appear as a "signifying totality" (a book, a computer) it is simultaneously always dismantling and reassembling (Deleuze and Guattari, 1987, p. 4). The notion of becoming, of future possibility, is thus crucial to the concept of an assemblage (Müller and Schurr, 2015, p. 219).

One of Deleuze and Guattari's most significant theoretical contributions is the notion of the rhizome. In contrast to a linear and progressive version of history as is often attributed to Marxist versions of materialism, the rhizome has no beginning and no end. In a rhizome, everything is connected to something, and there are no fixed positions. There is no complex, unified whole made up of fragmented, interacting parts each containing specific properties. Instead, relations are always exterior and any whole is constituted by the components exercising their capacities, capacities which are always different based upon the entities in the interaction (DeLanda, 2006, p. 11). A rhizomatic assemblage is always in the process of becoming and unbecoming, things are articulated, sediment, and then rupture and reform (Deleuze and Guattari, 1987, p. 3). Culture and history are explained through the rhizome as a flattened map of the agglomeration of diverse elements such as discourses, power, materials, and subjects (Deleuze and Guattari, 1987, p. 7).

Deleuze and Guattari's work has been built upon by numerous scholars concerned with understanding why things happen. Within media studies, the tradition of media ecologies, as outlined in the previous chapter, has been greatly influenced by Deleuze and Guattari's work. The emphasis on becoming is conceptualised as cycles, feedbacks, and loops of matter and energy. Anna Tsing uses Deleuzian and Guttarian concepts to describe reality as "open-ended assemblages of entangled ways of life" (2015, p. viii). Jane Bennett combines the work of Deleuze and Guattari with the work of Bruno Latour (introduced below) into a vital materialism, which affords matter a vitality, a capacity to effect and be effected (2010, p. 22). Bennett's work is part of a notable body of literature that has developed new materialism with a feminist emphasis.

Feminist science and technology studies

In this section, I briefly introduce two authors, Karen Barad and Donna Haraway, as examples of a feminist strand significant in developing new materialism as a distinct theory that considers "matter or the body not only as they are formed by the forces of language culture and politics but also as they are formative" (Frost, 2011, p. 70). Explicitly feminist takes on new materialism have contributed to an increased focus on the particular ways that things come to rendered intelligible as a subject or object (Frost, 2011, p. 74). Significant to the

development of this field is Barad's concept of intra-action. Intra-action understands the causes of an effect as constituting and arising in relationships between entities. Agency, the capacity to make things happen, is not something that pre-exists, but is continuously enacted (Barad, 2007, p. 112). Thus, reality is "is not composed of things-in-themselves or things-behind-phenomena, but things-in-phenomena" (2007, p. 104). Although I differ from Barad in understanding agency, arguing below that phenomenon result from the totality of interactions between a collection of actor-networks that interact in a network, her work bears mention as a significant contributor to a body of work that takes what she describes as an ethico-onto-epistem-ological approach. For Barad, knowing and being are mutually implicated (2007, p. 185). The separation of the two both results from and constructs a difference between human and non-human, and matter and discourse (ibid.). Barad's work explicitly deals with the ethical implications of the different identities that are created as intra-actions makes 'cuts,' creating both objects and different kind of subjects (different identities) (Barad, 2011, p. 149).

Within media studies, the insights from feminist science and technology studies offered by Haraway has been most influential. Haraway argues that "bodies are not born; they are made" (1991, p. 208). The bodies that we study are not ideologically constructed. Rather it is the boundaries that make them a particular, knowable object that "materialize in social interaction" (1991, p. 209). Haraway uses the term 'nature-cultures' to encapsulate the way that society and nature cannot clearly be divided, but instead are only separated as they came to be known as separate, through science. I return to this point, later in the chapter. Haraway's work has been used extensively to support scholarship that troubles an easy distinction between 'user' and 'device.' In her most recent work, Haraway utilises Barad's work of Barad to address the issue of how humans can 'live and die' well with the non-human entities we are connected to (2016, p. 116). For Haraway, companion species are all of the human and nonhumans that are "becoming-with" (2016, p. 13). Haraway uses the conception of string figure games to describe how species arise in the entanglements between subject and object shaping practices (ibid.). Whilst I take a different approach, which I outline below, feminist new materialism has shaped my work insofar as providing a blueprint for the ethical implications of my study.

Actor-network-theory

Developed in science and technology studies by Bruno Latour, John Law, and Michael Callon, actor-network-theory (ANT) has been influential within new materialist scholarship. ANT is understood here as encapsulated in the following definition by Law:

> Actor-network theory is a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations (2007, p. 2).

Within media studies, ANT has been used to study production cultures (e.g. Mould, 2009), in television studies (e.g. Teurlings, 2013), and in attempts to decentre the tradition within media studies to focus on human subjectivity *inter alia* (van Loon, 2017, p. 51). Like work inspired by Deleuze and Guattari, ANT takes an ontologically relationist view. As a theoretical orientation, ANT posits to explain the ways that phenomena act as a whole, by describing the relations between a cluster of actors. Crucial to ANT is the notion of the actor-network. For Latour, everything can be understood as existing in a network of relationships. From this network of relationships, agency arises. Latour notes that an actor is that which "is made to act by many others" (Latour, 2005, p. 46). The term actor-network is used to note that because the actor is a relational network, and thus the exact source of the action cannot be identified (ibid.). The relationships within this network are dynamic. Phenomena result from the associations formed between actor-networks, which are continuously influencing and affecting one another. In comparison with Deleuze and Guattari-influenced work, it places less emphasis on becoming, and takes agency as its central foci.

ANT sees agency, the capacity to act, as a "distributed achievement emerging from associations between human and non-human entities" (Müller and Schurr, 2015, p. 218). The goal of an ANT study is to map the "processes by which these associations are built, maintained and severed" (ibid.). In this regard, ANT allows waste to be conceptualised as arising a set of associations between actors. Waste is an actor-network, comprised of associations. In other words, waste as a phenomenon is always relational, resulting from the connections between human and non-human actors. Waste has agency in the sense that in the interactions between the actor-networks that make it up, effects are generated which cause things to happen. Similarly, waste as an actor-network interacts with and affects other actor-networks. ANT provides a useful framework to map when, how, and why associations are built and maintained through time. ANT demands attention to how specific relations came about, and how they are maintained through time. Further, as a theoretical approach ANT allows us to pay attention to the ways that waste as material relations can act in ways that exceed human representations and intentions.

ANT is particularly concerned with scientific knowledge: how it is made, accepted as true, and acts in the world. The concept of the black-box is particularly useful here. Black-boxes are technologies or facts made invisible by their own success, that despite their size or complexity matter only in terms of their input and output (Latour, 1987, p. 3). They appear as ready-made science, or self-evident truths. When something is black-boxed, all of the controversies, disagreements, and ambivalences related to that truth are obscured. Scientific and technological processes such as recycling and 'clean' energy generation are reified by Apple as solutions to prevent waste. The facts associated with these technologies are accepted as true, and as self-evidently 'good' and positive. The controversies inherent to any technological process are obscured. This has real world implications, as knowledge directs material realities, as we see particularly in chapter five. My rationale for employing ANT is that concepts associated with ANT, like black-boxes, provide a useful analytical lens and methodological vocabulary with which to both locate waste, and offer analysis into the relationships between such waste and the zero-waste discourse. It offers a way to build upon the insights borne from the political economy approach, highlighting the material effects resultant from associations ordered by zero-waste discourses.

Like the work of Barad, Haraway, and others described above, ANT is concerned with problematizing the notion of a division between nature and society. Latour argues that opposed to two separate spheres, everything in the world is always a hybrid, comprised of human and non-human elements. The boundary, or division, between the two spheres is ideological. Indeed, he argues that this boundary is one that the "social conditions and technological accomplishments of European modernity have been founded upon" (Hornborg, 2014, p. 122). The key task of a critical politics, for Latour, is to disassemble this boundary. Similarly, ANT dissolves the notion of a divide between structure and individual as reflected in the structuralist/post-structuralist debate outlined above. The tension between whether the individual or the structural has deterministic capacity is worked around by Callon and Latour who note the only difference between the two is scale. The structures traditionally studied by political economists (economics, capitalism, and so on) can be thought of as macro-actors because of their size, but they are not fundamentally different from smaller 'micro' actor-networks (1981, p. 284). It is through relationships between actor-networks that the capacity for action arises.

Critique of ANT often argues that in this way it renders agency as flattened, too focused on mediated interactions between nodes, and less capable to theorise the unexpected event

(Müller and Schurr, 2015, p. 219). Further, eco-Marxists argue that even accepting "dynamic, relational, and hybrid ontologies" does not override the need to accept that processes are not 'social' and 'natural' in equal measures. Power is not distributed evenly through such relationships and some actors (specifically, social actors) have more agency than others (see Castree, 2002, p. 135). Questioning the theory's usefulness for media studies, Nick Couldry argues that the theory has a "relative lack of interest in the long-term power consequences of networks' establishment for social space as a whole and its equality or inequality" (2008, p. 102). He notes that the theory is better adapted for an analysis of how networks are established than "in their later dynamics" (2008, p. 101). Put simply, ANT does not engage enough with why power differentials matter.

I respond to this critique first by noting that Couldry himself suggests ANT is well suited for the task at hand in this thesis of describing the waste network that Apple have built, and then parsing out the role that the scientific discourses of 'zero-waste' and 'circular economies' have played in such a construction. I suggest that it is not the case that ANT is ill-equipped as a theoretical language to describe the long-term consequences of these power asymmetries. In the coming chapters, I highlight many examples of relations that constitute wasting, harmful effects that result from the way that power relations have structured associations. At the same time, pace Couldry's charge of "political conservatism," I orientate myself within the ANT tradition because of the potential for radicalness (Couldry, 2008, p. 102). In ANT, nothing is 'sewn' up. Power is a relational effect, and must therefore be continuously maintained. In this thesis, I make the argument that it is through associations that generate waste that Apple is able to gain power. Mapping the actor-network of waste Apple has built reveals where power has sedimented, but also where power is least assured (Cupples, 2011, p. 946). Finally, I argue that when nothing is sewn up, there is always a way out. For those that live with relations of wasting, those people and environments that are harmed in order to perpetuate a networked, information economy, this is important. These people and environments embody why power differentials matter, but the task of mapping these associations must always be connected to the task of breaking them, a task ANT is particularly well suited to.

Concluding thoughts

In this chapter, I have charted the history of theories of materiality, and how they have influenced media scholarship. I argued that although much scholarship relating to media

materiality within media studies has utilised the work of Deleuze and Guattari, I will instead adopt a theoretical approach derived from ANT. The ANT approach follows other new materialist frameworks to reject a distinction between society and nature. E-waste, in this view is a phenomenon that is "simultaneously real, like nature, narrated, like discourse, and collective, like society" (Latour, 1993, p. 6). As Law argues, at the crux of the ANT approach is elucidating how "actors and organisations mobilise, juxtapose and hold together the bits and pieces of which they are composed" (1992, p. 4). Thus, the approach is particularly well suited to an exploration of waste within the actor-network constructed by Apple to produce the notebook. As will be demonstrated in the coming chapters, Apple build a network of waste by ordering associations to increase their power. These networks span time and space, and are actively maintained. ANT asks how these processes of ordering and structuring networks become seamless, and self-evident (ibid.).

I have argued that ANT provides a theoretical framework to show how particular scientific and technological realities are accepted as true. The consequences of this are demonstrated throughout the thesis as I explain how particular processes (such as recycling) are constructed as self-evidently 'good,' the controversies that surround them obscured. Finally, actor-network theory as theoretical underpinning goes someway to circumventing the risks involved with describing associations of wasting that necessarily involve humans. As an approach, ANT when deployed correctly, is particularly adept for the researcher who wishes to follow the approached called for by Yates detailed in the previous, and remain attuned to the possibility and incidence of resistance. No effect is permanent, and no human is waste. Wasteful associations can always be broken, and the task of the researcher is to identify where power is at its weakest. In the next chapter, I introduce the methodological toolbox I use to undertake such a task: the concepts of symmetry, translation, immutable mobiles, and obligatory passage points.

Chapter three
How to find waste? Methodology and method.

In the previous chapter ANT was introduced as the theoretical underpinning of this thesis. As noted, key ANT proponent Latour is not entirely convinced that ANT is a theory. ANT, however, is most certainly a methodology well suited to analysing the flow of power through networks, and it is introduced here as such. In this chapter, I reintroduce ANT as the methodology used to answer the research question. Translation, Obligatory Passage Points (OPP), immutable mobiles, and symmetry are briefly defined as the specific tools used. The methods, which will be outlined, include following the actors, discourse analysis, and auto-ethnography. Each of these methods has been selected as the best way to describe the various actor-networks within the greater Apple actor-network making waste networks visible. Waste networks are actor-networks structured in such a way that the associations they are comprised of give way to relations of wasting, typified by harm, depletion, idleness, and other deleterious effects. Ultimately, I argue that the ANT approach allows not only for a comprehensive description of these waste networks built alongside the notebook, but also allows for rich analysis of the associated power relations.

Actor-Network-Theory (ANT) Methodology

The ANT approach to methodology, as suggested by the preceding chapter, is concerned with elucidating how power is distributed through networks. The network itself, Latour explains, is not a "thing out there" but a concept to describe translations (2005, p. 131). For the purpose of this thesis, the translations being described relate to waste, focusing analysis on the way that waste roles are created and maintained. This involves examining who the network builders are, and whose interests are being served in the creation of waste networks. Per Latour, the waste networks I refer to are not tangible things, but accounts that brings together particular associations. It is these associations that form particular waste 'actors' (Krieger and Belliger, 2014, p. 58). As a tool, the network foregrounds connections between different forms of waste and highlights how particular actions bring about waste. As mentioned in the previous chapter, ANT posits there are no overarching 'structures'. Instead, macro-actors like networked capitalism are relational effects that recursively generate and reproduce (ibid.). As these structures are relational, no structure is final, and resistances and contestations are inherent.

It is worth noting here that Latour himself does not find 'capitalism' a useful analytical term. He argues that when capitalism is critiqued, it is critiqued as a "total system" that must be "totally subverted" (2014, p. 8). The implications of this, for Latour, are twofold. Firstly, denouncing capitalism in this way only ends up renouncing it (2004, p. 276). Discursively constructing capital as a totality in order to overthrow it actually reinscribes it as a totality, when it is in fact not (Latour et al, 2018, 591). As a totality, it is allowed to be defined as a set of "internalities without the externalities it has produced" (ibid.). Further, attempts in the 20th century to revolutionise capital (through socialism) only served to embed the system (2014, p. 8). Secondly, appealing to capitalism engenders helplessness, as confronting its totality increasingly seems impossible (2014, p. 9).

Capitalism, then, is a term Latour suggests abandoning entirely. I'm sympathetic to Latour's position. What response but apathy is there to a totalising system? Yet I follow anthropologist Anna Tsing in using the term, for the critical edge it has in connoting that the present organisation is a recent phenomenon, and amenable to change (Latour et al, 2018, p. 593). What is useful about ANT is the way it enables us to see how a large network forms, and comes to be 'spoken for' by concepts like capital. As Latour has argued in relation to the term Anthropocene, the term capitalism "speeds up the argument" by denoting a set of relations between economic policies, algorithms, traditions, discourses, ideologies, humans, and materials *inter alia* (2018, p. 599). These relations are not total, the network can always be destabilised. Nonetheless, I argue that capitalism is a useful term to describe a set of relations that have been ordered and maintained in a particular way.

'Translation' is the ANT term that describes this process in which networks are ordered, actors are bought together, and 'held' into networks. Through this process of translation, one seemingly stand-alone 'actor' will come to stand for an entire actor-network[1] (Law, 1992, pp. 5-6). Translation creates and defines roles for actors, and as they take them up, they are enrolled. When translation is complete, the actor is able to 'speak' for the network. This power is not definitive. All networks require work to keep them together. This is because any given actor-network is always in interaction with other actor-networks. Without constant maintenance, there is always the possibility that the network will be destabilized by a recalcitrant actor-network (Teurlings, 2013, p. 104).

[1] In this study, the terms 'actor-network' and 'actor' are thus used interchangeably unless otherwise stated.

There are two key strategies used to translate networks. Firstly, actors build and order networks to meet their goals by establishing themselves as an OPP. Actor-networks make themselves indispensable to others, putting themselves in a position of power. The *ERR* analysed in the following chapter both reflects and constructs Apple as an OPP. Secondly, actors gain power through the creation of 'immutable mobiles' that structure networks across space (Law, 1992, p. 6). These are a set of knowledge technologies that are standardised so that a global network can be managed from one centre (Latour, 1987, p. 234; Teurlings, 2013, p. 105). In chapter six, knowledge technologies are at play in the policies and procedures that dictate how Apple's third-party recyclers in New Zealand can act. These policies provide Apple with a means of controlling their network at a distance.

Because ANT posits that networks are always human and non-human, as a methodological approach distinct from other approaches it is characterised by a high-resolution focus on the non-human actor (Ochsner, 2017, p. 223). In practice, this means less of a focus on 'why' a network is, and more of a focus on 'how' it is. As Law and Callon (1998) describe, the ANT approach is concerned with following actors, mapping the way that "they define and distribute roles, and mobilise or invent others to play these roles" (p. 285). This close, sustained attention to relationships between non-human and human actors enables a rich understanding of waste networks as simultaneously intentionally created, and not entirely under human control.

If each actor is different, it makes sense that each actor requires different tools in order to tell their story. Symmetry within ANT refers to the principle that any human or non-human actor may be responsible for an effect, and power should not be presumed in advance (Cressman, 2009, p. 3). While different tools may be used to generate knowledge, an ANT inspired symmetry demands that the same analytical and descriptive frameworks be employed to describe each actor (ibid.). The advantage of the ANT approach is that it allows for dual descriptions of human and non-human actions, providing a nuanced and complex understanding of the waste associated with my notebook. Nonetheless, ANT has been critiqued for failing to attend to the inequalities that power imbalances between the human and nonhuman actors cause, over-concentrating analysis on the formation of networks. By carefully deploying concepts like 'black-box' to show how particular relations are maintained, and the attendant consequences of the continuation of particular associations, this can be avoided. In the following section, I introduce the specific methods used.

Discourse Analysis

Discourse analysis will be carried out on Apple's *ERR*. This discourse analysis fits within a broader analytical framework that pays attention to "material circuits, flows of matter, and non-human assemblages" without losing sight of the role of human intention in such a process (Coole and Frost, 2010, p. 13). Human ideas, practices, beliefs, and intent undoubtedly play a large role in organising the associations between actor-networks, which has immense consequence. Discourse analysis is employed here, then, as the most appropriate way to elucidate the ideas evident in the *ERR* that play a role in structuring the waste networks relevant to the notebook. Human practices of representation, of course, do not determine such waste in entirety. The ANT approach enables these ideas to be parsed out to whilst remaining attuned to the fact that matter is not inert, and contains its own ability to in shape discourse (Lundborg and Vaughn-Williams, 2015, p. 24).

To do this, complementary ideas from Foucauldian discourse analysis and ANT are employed to examine how knowledge and truth are produced, and to ascertain how these discourses obtain authority (Wetherell, 2001, p. 286). From a Foucauldian perspective, discourse makes waste exist meaningfully. That is not to say that things do not exist outside of discourse, but that it is only discourse that gives these things meaning (Hall, 2001, p. 73). The aim of the Foucauldian approach, then, is to attempt to uncover the "structures of meanings" and "configurations of feelings" that discourse is rooted in (Hall as cited in Steiner, 2016, p. 104). However, the work of Kittler troubles this position somewhat, noting that that the medium through which a text is transmitted does have a role in shaping the discursive event (as cited in Winthrop Young, 2016, p. 83). The material elements of the medium through which discourse is conveyed contain meaning insofar as their material make up determines what can be said and how it can be said. Latour himself understands discourse as a population, where material things mix with societies, in the process upholding and constructing them (1993, p. 90). Here, I combine these approaches to undertake a discourse analysis to elicit the conditions of possibility that arise in the interactions between actor-networks which include textual elements. The particular material forms the text takes plays a role in determining how these representations take place, the particular conditions under which the knowledge can be represented. A Foucauldian analysis on its own is inadequate to attend to these conditions.

Similarly, on its own, ANT has been criticized as an inadequate method to address the complexities of the way that images are interpreted and represented in the media, with no tools to discern between representations with 'good' and 'bad' consequences (Couldry, 2008a, p. 166; Knorr-Cetina, 2001, p. 527). Employing the Foucauldian method provides the tools and language to attend to the consequences and historical contingency of the particular

representation offered in the *ERR*, whilst undertaking an analysis of the networks it builds and sustains. Following Stuart Hall's interpretation of the Foucauldian discourse analysis method, the approach employed here maps this actor-network by examining the statements in the *ERR* that give the reader knowledge about waste. It identifies the 'rules' set out for knowing waste, noting what can and cannot be said. The approach identifies the roles created, as well as demonstrates how this knowledge has come to be thought of as true, and describes the historicity of the knowledge (Hall, 2001, p. 73). Ultimately, the discourse analysis aims to describe the way that Apple's interest is translated into "material form," reflecting and enacting a particular reality (Callon, 1991, p. 143; Nimmo, 2001, p. 114).

Follow the Actors

Within the ANT approach, following the actors is used as a way to open black-boxes. The problem with this approach, as Latour himself has noted, is that there are a potentially infinite number of connections between actor-networks that relate to my notebook. In the introduction, I noted that I would utilise case studies. This means that only a portion of the actor-networks of waste will be mapped here. The case studies selected have been chosen to foreground discussions that focus on waste networks that relate to the notebooks design, extraction, production, use, and disposal.

It is often the case when seeking to uncover the conditions of a particular scientific or technical phenomenon that the builders of the network in question are chosen as those to follow (Latour, 2005, p. 40). This is in part the approach I take; the creators of the notebook (Apple) do receive sustained focus. It is not the case, however, that other, less powerful actors are ignored. The focus on Apple and waste is important for understanding how those actors that are more powerful are able to ascribe roles to others in the network, and how those roles are fulfilled (or not). As I expand upon in chapters six and seven, and as numerous scholars featured here such as Cubitt, Gabrys, and Maxwell and Miller point out, individual consumers are not solely responsible for e-waste (2016; 2011; 2012). Power is not distributed equally within networks, and a generalised symmetry does not prescribe equal consideration. The task is to map where waste occurs in relation to the notebook, paying close attention to how both waste and the 'zero-waste' discourse have been employed to build and sustain Apple's power and influence.

Finally, 'Apple' and 'waste' appear as coherent actors. This is not the case. 'Apple' and 'waste' are relational entities, networks in and of themselves comprising a disparate collection of actors that have been translated and black-boxed. Apple, for example, is

comprised of staff across the globe, particular devices and products, websites, discourses, advertising texts, representations in popular culture, and stocks *inter alia*. This disparate actor-network is held together using various strategies. Where 'Apple' and 'waste' are referred to throughout, the terms denote black-boxed, relational actor-networks. Elucidating the processes through which actor-networks of waste are built, maintained and obscured, is what will answer the research question. Using knowledge generated through discourse analysis, 'desk' research[2], and auto-ethnography, I follow these actors through case studies of the *ERR*, the HDD, the aluminium casing, and the replacement of the battery.

Auto-Ethnography

Within this study, auto-ethnographic methods are employed to produce knowledge about obsolescence and the user experience of failing electronics. Auto-ethnography is a method for understanding cultural or social phenomenon through personal experience (Stokes, 2013, p. 11). As consumer magazine *Consumer Reports* notes, computers and notebooks frequently develop faults, with one in three notebooks "breaking by their fourth year" (2011, p. 25). Auto-ethnography has been chosen as a tool well suited to explore the relatively mundane occurrence of addressing the seemingly failing notebook battery. With routine experiences like this, verbalising motivations and thought processes within the interview setting can be difficult (Uotinen, 2013, p. 4). Whilst I do not presume that my experiences will be entirely generalizable, the richness and precision afforded by detailing my own experience gives an interesting perspective into things becoming obsolete, as a component of the waste associated with my notebook (Uotinen, 2014, p. 5).

What happens to ICT devices once they are no longer considered useful is relatively understudied. Most studies have been large, quantitative reports (e.g. Bovea et al, 2018; Sabbaghi and Behdad, 2018; Scott and Weaver, 2016). As Bovea et al note, a limitation of such studies is that research participants often are uncertain in their memories regarding the specifics of the decision and process of repairing or discarding (2018, p. 601, 609). Yet concentrating

[2] The synthesis of information found through searching a range of sources and texts including academic sources, the internet, documentary footage, and so on. Information about my specific notebook was found using the coconut ID app, which uses serial numbers to calculate manufacturing details of Apple products ("coconutID 3.4," 2015).

on the way that things can be materially fragile, and thus requiring of constant care and attention, opens up a fertile space in which to explore issues of materiality, object agency, and the roles of objects in society, particularly in their construction as 'waste' (Denis, Mongili, and Pontille, 2015, p. 8). Employing the auto-ethnographic method here addresses the research question in providing insight into the way that objects transform into waste. Contra to the anthropocentric connotation of the auto-ethnography, the method allows me to attend in intimate detail to the role of changes in the notebook itself.

Concluding thoughts

Networks are by nature heterogeneous, structured by power relations. Because of this heterogeneity, three different tools have been introduced here as the methods by which particular networks will be mapped. Discourse analysis that combines Foucauldian and ANT approaches is utilised to chart the ideas that structure Apple's approach to the waste within their networks. The results of this analysis are presented first to enable me to draw attention to the incongruities that arise both between Apple's conception of waste and my own, as well as between Apple's plan and what is currently happening within their networks. Elucidating these waste networks in relation to my notebook is done using the follow the actors approach, selected as the most appropriate way to map connections between a set of actors that are occur at different positions in time and space. Finally, auto-ethnography has been presented as a tool well-suited to explore the routine and intimate phenomenon of dealing with a malfunctioning notebook battery. This chapter comes last as these insights form the basis of a final reflection of the efficacy of the zero-waste network, and informs my position on what might be done in regard to the waste networks mapped here.

As a researcher, I have selected a range of methods appropriate to different actors. It is my hope that in interaction with these right methods, this human and non-human world becomes well-articulated. The right research tools allow the common worlds of waste to 'speak,' and reveal incidences of wasting otherwise invisible (Bateman, 2014, p. 52; Latour, 2004, p. 86). Yet as has been argued in the previous two chapters, there is always the risk that mapping waste relations enacts waste relations. Methodologically, ANT provides a useful tool to circumvent this. Symmetry, the principle of 'flat' mapping where all actors are considered equally, affords those currently detrimentally implicated within waste networks the same amount of potential for action as the powerful network builders. The network map provides clues as to where this potential is at its strongest, and conversely where the powerful network builders potential is at its weakest. Thus, the ANT approach detailed in this chapter brings into

focus the power relations that have structured such a network, and to that end can help find solutions to relations of wasting. In the next chapter, the *ERR* is introduced, and I begin to demonstrate how Apple have built a network of waste.

Chapter four

Shaping waste realities: A discourse analysis of Apple's *ERR*

In this chapter, I introduce the *Environmental Responsibility Report (ERR)* as a significant actor-network that articulates what Apple consider waste to be, provides an overview of where they think such waste arises in relation to their products, as well as both reflects and enacts processes of enrolment whereby Apple have enlisted actor-networks into a network related to waste. To create the notebook, and then market it to potential consumers, Apple build actor-networks through enrolment. Over time, the notebook has been black-boxed to become a ubiquitous, self-evident technology. The constitutive associations between actors, including associations that can be thought of as waste or wastage, have resultantly been rendered invisible. The *ERR*, which is found on Apple's website, is an actor that was introduced in order to make some of these relationships visible in response to critique of Apple's environmental practices.

Here, I provide a brief introduction to the report, before reintroducing the concept of translation. I describe how the report functions both as a reflection or sedimentation of the process of translation where Apple have gained the power to speak for and represent a range of actors, and also as part of the process of translation where particular ideas and practices are associated with the goal of enrolling others into the network (Nimmo, 2014, p. 114). Following a description of how the reality the report reflects is legitimated through scientific discourse, I look at the characteristics of both the actor 'waste' and those employed to act upon waste within this particular network, and describe how this reality has been historically constituted. As with the notebook, waste is black-boxed. The particular knowledge of waste disseminated by Apple is presented as true, and beyond question. Ultimately, I argue that the report simultaneously reflects and creates a situation where ideas about waste and environment are used by Apple to strengthen their position as an actor. Whilst not entirely deterministic, this has important consequence in arranging the associations between matter, energy, and ideas that come to be thought of as waste.

A brief history of the *ERR*

In 2006, Greenpeace published the *Guide to Greener Electronics,* which ranked Apple a 'bad' performer. They noted that Apple performed poorly in regard to phasing out toxic chemicals in their products, and 'partially bad' in many other areas from chemicals management to the provision of consumer information in regard to takeback (which was only

available in a handful of countries) (Greenpeace 2006 p. 2, 3). In response, "A Greener Apple", authored by CEO Steve Jobs, was published on Apple's website. The document served to outline the environmental intentions of the company, and defend their environmental credentials (Jobs, 2007, p. 1). It was claimed that Apple were actually leading, or would soon lead, the field in regard to toxic chemicals and recycling (Jobs, 2007, p. 3). Addressing Greenpeace's complaints directly, the report highlighted that Apple planned to eliminate brominated flame retardants and polyvinyl chloride by the end of 2008, and likely would be recycling more than Dell or HP at the end of 2010 (if measured as a percentage of all goods sold). Jobs wrote that after investigating his company's practices he felt that the company were communicating their successes poorly. Environmental and humanitarian values at this point were firmly established as part of Apple's brand (Kahney, 2002, para. 18). "A Greener Apple" can be seen as an attempt to restore continuity with the conscious, responsible company image tarnished by the Greenpeace report. The company has annually published a report that relates to their environmental progress ever since. The reports generally all follow a similar structure, reporting on the key themes of climate and energy use, resources, and safe materials.

Ask less of the planet: A shared goal

The environmental reports do more than just describe Apple's environmental progress. Through translation, the report acts to enrol potential Apple consumers. Within ANT, as introduced in the previous chapter, 'translation' refers to the study of a process by which a network of relationships is constructed, "during which the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited" (Callon, 1986, p. 6). For Apple to control who they are, gain power, and achieve their goals, they need to establish themselves as an actor that others need. They need to become an OPP (Lippert, 2011, p. 290). In order to do this, obstacle problems are created for other actors that make them believe that they have a particular goal, something that hinders the ability to achieve that goal, and that Apple have or are the solution (Callon, 1986, p. 25; ibid.). Provided these other actors are interested, they are enlisted (Callon, 1986, p. 10). As the actors take up the interrelated roles defined and attributed by Apple, they are enrolled (ibid.). These roles may or may not pre-exist the network being built (Callon, 1986, p. 10). If the process of translation is successful, Apple can represent the other actors in the network, "speaking and acting for the others" (Lippert, 2011, p. 290). In this way, Apple gains power.

The *ERR* is simultaneously a strategy used to enlist actors, a reflection of the process of enrolment, and a reflection of the process of translation more broadly. That the text can be

thought of as reflecting these processes does not mean the text is necessarily a reflection of 'reality'. Assessing veracity, however, is not of particular importance in this chapter. It is more significant to note where it is likely that some actors and relationships have been omitted from this text. The goal is primarily to describe the networks Apple have presented here as relating to waste, and the networks being built with those presentations. In the broadest sense, the network and networks-within-networks displayed and constructed here can be thought of as being built using some variation of the goal stated on page three, that is, "to ask less of the planet" (Apple, 2017, p. 3).

This goal "to ask less of the planet" is constructed as a goal that is shared between the reader of the text and Apple. The reader is likely an Apple consumer, evidenced by the use of pronouns that indicate possession, as in the sentence: "We take responsibility for every watt of power you use on your device" (p. 14). The obstacle problem through the text is constructed as business practices that are environmentally unfriendly, which worsen existing problems relating to climate, pollution, and scarcity. Further, Apple state they wish to "inspire" others in their industry (amongst others) to make similar changes to their business practices (p. 4, 17, 19, 32, 33). In making this claim, they establish themselves as an industry leader. Their business practices are the solution to a shared problem. Engagement and mutual learning with other industry, sector, and sustainability players ties closely with the stated belief that "companies can make a difference" (p. 32). The inscription of themselves as industry leader creates one reality where they are the industry leader, and the reader of the text is invited to take up this reality. The solution offered to the reader is to purchase Apple products. The notion of purchasing is significant here. An association is being made between environmental sustainability and buying better products. The implication of this, which I will return to through the chapter, is that it strengthens Apple within the network of relations that can be conceptualised as consumer-capitalism. As a provider of a consumer good, this association is a tactic by which Apple maintain and increase their power. Accepting that the *ERR* reflects and creates a waste-network within the context of consumer-capital, I will examine the role/s Apple creates for waste, parsing out the characteristics they assign to it, and the human and nonhuman subjects that act on it.

The characteristics of the role(s) of waste

The *ERR* outlines Apple's plan for how they relate to the environment. It describes the different entities that constitute their conception of the environment, outlines the parts of their supply chain they see as relevant to the environment, and most importantly for our purposes

here, describes how they think of waste. Waste is set out in the document as being a particular type of actor (or set of actors). I examine the positions that such actor/s must occupy in order to be the subject of these statements, and the way they are constructed as truths (Foucault, 1972, pp. 95-96).

Throughout the text, Apple use scientific discourses to describe waste. The language of science connects Apple to wider discourses linking environment and science. Governing bodies, for instance, obtain information from scientific communities, fund research, and make decisions based on science (Bocking, 2004, p. 3). As Barry Barnes and David Edge note, in order to be "trusted as an interpreter of nature (one) needs a license from the scientific community" (as cited in Fischer 2000, p. 87). Using scientific techniques to describe waste (offering measurements of it, for example), is to connect Apple's knowledge about waste with what is established as salient, true ways of knowing the environment (van der Hel and Fiermann, 2017, p. 211). Using these techniques gives Apple credibility, through implications of ideological neutrality that is free from political or corporate bias (van der Hel and Fiermann, 2017, p. 217). Statements about the different organisations the company collaborate with and the provision of evidence of external auditing confirms the validity and verifiability of the report (ibid). These factors give Apple a social license to operate, and lend authority to the particular definition of waste introduced as follows.

For Apple, waste varies in constitution. The *ERR* mentions waste explicitly as taking the following different forms: "waste heat" (p. 6); "building demolition waste" (p. 11); "shipping waste" (p. 15); as material waste that arises in the supply chain, such as packaging, or manufacturing by-product like wastewater (p. 19, 20); and finally, "office waste" associated with the supply chain, most specifically paper or food waste (p. 19). Waste is always non-human, a resource expended unnecessarily (radiating heat, leaking water), or a material that is no longer needed (an apple core, a box, a building). Because waste is heterogeneous, the "specific properties of each material" mean that differing approaches are needed to deal with it (p. 17). Notably, waste, within this document does not explicitly take the form of a discarded Apple product. Instead, another role is seemingly created encapsulated by the term "end of life products" (p. 15). The recycling robot Liam acts not on 'waste' but on "products returned through the Apple Renew programme" (p. 4). Waste, that is, is never mentioned in the context of a used Apple device. Choosing not to define the Apple used and unwanted products is an attempt to divorce them from association with the idea that discarded Apple products cause social and environmental harm. That this harm is concealed is significant, and demonstrates that Apple's power is never sewn up, and must always be maintained relationally.

The notion that Apple products are discarded in ways that cause social and environmental harm itself is an actor within a wider network that threatens to destabilize the narratives Apple uses to gain economic power. It threatens the continued consumption of their products. Other actor-networks in this counter network include waste workers, environmental activists, photographs of waste workers picking over burning piles of rubbish, polluted rivers, and illegal export practices *inter alia*. Within this network, Apple does not control the representations of itself. Rather in this network other actors (like Greenpeace) speak. It is not the case that this network is separate from the Apple supply chain. In fact, the illegal waste practices represented in such a network are essential to Apple's continuing power by way of enabling the potential Apple consumer the chance get rid of and replace Apple products.

These particular waste practices, as actor-networks, are less definitively enrolled than others within the Apple actor-network. Of course, no role is ever definite, or fixedly durable. By way of necessity, however, these actors must be kept 'at arm's length'. Many of these practices are illegal, and many more considered immoral enough to threaten Apple's social license to operate. As their obscuration in the *ERR* suggests, they are not associations it is in Apple's interests to publicize. Being unable to speak literally on behalf of such actors means they are subject to less control than others. The potential for them to become dissident is thus even greater. When illegal export practices associate with a journalist looking for a big exposé on e-waste, when illegal waste pickers associate with a camera and activist, or when a Greenpeace report associates with a large database of potential Apple consumers, agency, the capacity to make things happen, arises in the interaction. The effect these interactions may produce is undeterminable, and depends on other actors the nascent networks come into contact with, and how much power they can garner to enrol further actors. Nonetheless, these interactions inherently have the capacity to threaten the stability of the entire Apple network. Staying quiet on particular characteristics of waste is both necessary and risky for Apple.

Of course, Apple can never be entirely silent on the undesirable characteristics of waste. Whilst they may obscure particular aspects of the end of life product's representation, that waste is harmful cannot be entirely obfuscated by Apple. Such a representation would stray too far from what potential Apple customers likely know about waste. Thus, the *ERR* tightly defines and delimits what the undesirable characteristics of waste look like. Waste in the Apple network is hazardous, that is, but only under particular circumstances. This property is discussed explicitly, for example in the description of how hazardous waste is treated "responsibly" using "strict" protocols and audits (p. 19). The hazardous nature of waste is also stated implicitly, as in the assertion that programs are being designed for the corporate offices

and retail stores to "minimize the environmental impact of the waste we produce" (p. 19). What this environmental impact might be is not elaborated on. Instead, the reader's aforementioned wider knowledge is invoked to fill in the connotations of waste. Wider discursive practices construe waste as something that is 'bad' for the environment. The contemporary framing of plastic waste as 'crisis' exemplifies this. As Hawkins outlines, knowledge of waste comes from a multiplicity of ideas rooted in science, morals, and emotions about what should not be allowed to be wasted, and provokes a litany of emotion and anxiety (2006, p. vii). But while this wider framing is invoked by Apple, solutions are offered. Waste, it is argued in the *ERR*, needs only to be recycled, incinerated, reused, or composted to prevent hazard (p. 19). The landfill, however, is definitively not the site for waste.

Apple argue that "traditional supply chains are linear. Materials are mined, manufactured as products, and often end up in landfills after use" (p. 16). The *ERR*, however, firmly establishes that ending up in landfill is not a desirable outcome. Apple want to put materials to "better use" (p. 16), and claim to be working on "finding new ways" to avoid their materials ending up in landfill (p. 19). Avoiding landfill as an idea has a particular moral currency given the 'waste is bad' discourse outlined above. Beyond this, Apple argue, waste should not be landfilled as it can be valuable. Value, as an idea, has associations with the idea of quality. Value may be economic, moral, or ecological *inter alia*. The value Apple is concerned with here is economic. Crucially, the properties of a specific material that determine quality and its economic value are not linked in every case. Instead, the value to which Apple appeals is a market trait. Any waste has exchange value when there is a demand for its supply. The exchange value can be (but is not always) separate from use value, which refers to the utility of the waste in question. A material with no use value can be exchanged, and a material with use value may not be exchanged. Exchange value, more so than use value, is a determiner of waste-as-materials trajectory. A useful material may end up in landfill when its exchange value is exhausted, and a material with little utility may end up exchanged indefinitely. In the latter the scenario, the actors in the material network in question will continue to associate with their surrounds, may be moved, or eventually be entirely severed of all but the faintest association to processes of exchange. Waste presents itself as a challenge to Apple when it is of "low-or-no value" (p. 19). In this scenario, a material cannot be exchanged or used. It is not viable for a market to develop around its recycle or resale. The fate of such a material would usually be landfill or illegal dumping (at cost to Apple). In order to overcome this problem, Apple posit innovation.

Apple expressly link innovation and environmental solutions. They invest in furthering academic research and contests that focus "on creative solutions to environmental challenges, governance, and public administration through entrepreneurship" (p. 33). Specific to the relationship between waste and innovation, the report outlines how 'inventing' Liam was an act of innovation, spurred by a lack in the market for recycling technologies that meet Apple's need for high grade materials (p. 17). Liam is a solution to waste borne of the market (p. 32). Along with other environmental innovations and measures implemented by the company, he is heralded as an example of how Apple "can show the way to a better future" (p. 4). Here, the text invokes wider discourses that surround the circular economy. These new capitalist discourses rely heavily on digital technology to spur and support innovation, reduce carbon intensive travel, and support the increased communication requirements of extending the life of materials (Lacy and Rutqvist, 2015, p. xviii). Given the potential for Apple, a provider of digital technologies in such an economy, it makes sense that Apple would want to mobilise the ideas associated with it (Vonk, forthcoming). The ideas that Apple are mobilizing increase their power. By adopting ideas about sustainability and environmental stewardship, Apple (and capitalism more broadly) gain moral legitimacy and temper opposition rooted in environmental concern (Tulloch and Nielson, 2014, p. 27).

Innovation is thus construed as an essential process for dealing with waste. Recycled aluminium, for instance, is not available on the market at a quality that meets Apple's need, as it is generally degraded as a result of having been mixed with other materials in the recycling process (p. 17). This is because currently there is not a large enough demand to warrant a more targeted approach to recycling waste electronics. Apple have found a solution in recycling only their own products with more specialized technology to better recover their own, already high-grade materials. Such a solution represents an innovation, a new idea that meets a specific market need. Innovation was spurred by the ability to profit. Apple's focus on innovation construes it as a voluntary corporate action driven by market factors. What is implied by such a construction is that innovation that bears positive environmental outcomes could not have occurred in a situation where a mandatory legal framework is prescriptive about what happens to waste. Apple voluntarily collecting all of their own high-grade products to recycle has more environmental benefit than them being mandated to collect mixed e-waste to the value of the weight of their products sold as is the case in many US mandatory take-back schemes. Such an implied proposition works because it is constructed as being more efficient. Recycling only their high-grade aluminium keeps it at a higher utility. What is not stated here is that such a situation is also efficient for them, and saves them the cost of finding third-party recyclers to

recycle the other e-waste they are legally responsible for. Nonetheless, 'efficiency' is a rhetoric employed frequently by Apple.

For Apple, waste is often the result of practices and systems that are not working as effectively as possible. At times, this is stated explicitly, as in the sentence "recovering waste heat" (p. 6). More often, it is implied. In either case, inefficiency is undesirable. For example, the *ERR* notes that waste may end up landfilled. It constructs this as negative, by way of outlining better strategies and appealing to the reader's prior knowledge. The report argues that things end in landfills at least partly because existing recovery technologies are inefficient, and "only recover a few kinds of materials and often diminish their quality" (p. 17). It follows that if waste results from inefficiency, to eradicate or mitigate waste concerned actors need to become more efficient. Through such discourses of efficiency, Apple increase their power. Most simply, Apple's efficiency is evidenced in fairly straightforward swaps to actor-resources that meet some criteria of being less harmful or resource intensive, like in the case of the use of sugarcane industry by-product instead of plastic packaging waste (p. 23). Such moves are largely posited as a solution for the consumer responding to an obstacle problem. Put simply, 'to protect the environment from plastic packaging buy Apple'. Secondly, to be efficient is construed as a skill, a skill that Apple possess and can teach. This is evidenced by the energy efficiency training program Apple report they delivered to representatives from 19 supplier sites in 2017 (p. 6.).

Thus, in purporting that they have the solution to the problem of inefficiency, Apple become an OPP and increase their power both with consumers and their supply chain. As an OPP, they may even become implicated in other supply chain-networks. A further obstacle problem, for example, is presented in the recycling technique of "shredding," in that it can only recover and separate a few materials, and decreases the quality of those materials (p. 17). Apple offer the solution with their invention of Liam, and they express their desire for others within their industry to be 'inspired' by it (p. 17). The efficiency they purport to possess in this example acts a solution to what is being constituted as an industry wide problem. If other actors within their industry take the technology up, Apple gain extra power to set industry conditions. What is more, discursive associations between discourses of efficiency and technology that likely pre-existed the consumer-reader's encounter with the text are strengthened by the *ERR*. Again, this connection is one that expressly favours Apple (given they are the purveyors of efficient technology).

To market, to market, to buy a better environment

It is only within a particular historical setting that Apple can 'speak' as an ethically and environmentally minded corporation. Put differently, it is in the interactions between diverse actors with goals that are both competing and complementary that the conditions which make Apple, the sustainably minded corporate that is being reflected and constituted by the *ERR*, possible. These actors include large, black-boxed networks (network capitalism), and small networks (one ethically-minded shopper). Of particular significance for this analysis is a nascent actor-network, the 'circular economy.' Briefly, the circular economy can be conceptualized as a network of discourses, research, corporate actors, and activists *inter alia*. These disparate actors advocate for a 'new' economy where materials are put through cycles of use and re-use to extract the maximum value from them to lessen the impact on the environment. Such economies are intended to contrast with environmentally destructive traditional capitalist economies of single use and disposal (Murray, Skene, and Haynes, 2015, p. 371). Circular economy actors are concerned with increasing the sustainability of capitalist economies, and thus do not position themselves in opposition to them. The circular economy does not inherently condemn economic growth or having profit as a guiding motivator. Circular economy principles such as being energy efficient or zero-waste can in theory be adopted by corporations without jeopardizing their bottom lines. This being given, it is somewhat incongruent that many of the concepts that underpin the circular economy had genesis in approaches that stressed the limited, finite nature of the earth.

Yet the circular economy's conceptual underpinning draws from 1960s and 1970s approaches to ecology that stressed such approaches, along with the neoliberal focus on the individual of the 1980s, and the sustainable development focus of the 1990s. During the 1960s and 1970s, the notion of ecology informed much thinking about the environment. These approaches differed greatly in their emphasis, but generally shared an opposition to ever increasing growth and industrialization (Tulloch and Nielson 2014, p. 28). In both the scientific and popular imagination, ideas about pollution, peak oil, and conservation of wildlife and natural resources became the hegemonic way to understand the environment (Kline, 2011, p. 95). These specific ideas informed what it is to be 'sustainable', and spurred an increase in regulation, legal challenge, and an environmental bureaucracy to a degree that they had not previously (Kline, 2011, p. 95). This is not to say that environmental regulations or concern did not exist prior, nor that other ways of understanding environment were not employed during the 1960s and 1970s. Rather, these ideas prevailed at that particular moment.

During the 1980s, neoliberal orientated policy led to the roll back of these regulations, particularly in the US, and fostered a general climate where environmental issues were less

important than other projects, namely the economy (Kline, 2011, p. 115). Approaches to the environment during this time often took an either or with the economy – save the environment, or save jobs. Individualized solutions to environmental problems, such as consumer recycling programs, were heavily promoted during this period. At the same time, awareness of a global division between the resource rich but industrially underdeveloped Southern Hemisphere, and the industrially developed and richer Northern hemisphere was mounting (Kline, 2011, p. 124). Apparent to richer, Western nations were poverty, sanitation, and political issues in the South, making the countries they depended on for resources increasingly unstable (ibid.). As such, during the 1990s the notion of sustainable development was introduced, which recognized both the need for ongoing development and growth alongside environmental realities such as climate change. Although a heavily contested term, 'sustainability' has spread as the prevailing way of conceptualizing the environment (Egelsten, 2012, p. 13). The circular economy combines the notion of sustainable growth with a focus on individual action inspired by neoliberalism, and a recognition of the finite nature of some resources drawn from ecology movements.

Waste Actors

Just as Apple have defined waste, they have also defined roles for other actors, both inside and outside of their supply chain, to 'deal' with it. This section highlights some of the key actors that have been introduced, as well as remarking upon some of the actors that have been obscured. In outlining these key actors, we get a sense for the level of responsibility Apple feel that they have regarding waste. Firstly, Apple employ 'waste monitors' that ensure resources are used as effectively and responsibly as possible. Monitoring is used to prevent the improper use of these resources. The waste monitor is an actor that may be human, or non-human. Their role is to assess, detect, and evaluate waste. An example of human waste monitors is the "zero-waste" or "green" teams in the Apple Watch and iPhone final assembly factories (p. 19). These teams support waste reduction through monitoring the facility's waste practices, implementing interventions to reduce waste, and making "other environmental improvements" (p. 19). Non-human actors often focus on measuring and reporting incidences or leakages of waste. For example, preventing water wastage is reported to be important to Apple so they endeavour to "hold themselves responsible" for the water they use (p. 20). Outside of the Apple supply chain, the human-led actors, company 'UL', take up the role of waste monitor. They assess and validate Apple's zero-waste status (p. 19). Organisations that monitor and critique the company's waste practices, such as Greenpeace, are not mentioned as actors in the *ERR*.

Such a move decreases the visibility (and thus, power) of an actor that threatens to destabilize the Apple network. Similarly, the 'waste sorter' introduced below is not a worker preparing e-waste for illegal export or at an illegal dump site.

Secondly, 'waste sorters' sort waste streams into individual components, or are actors that capture only a particular type of waste. Better sorting of waste is important to Apple. As discussed earlier, increased efficiency in sorting correlates to increased opportunity in regard to re-use. The role of the waste sorter delimited by Apple in this document works within the Apple supply chain. Examples include: the "food scraps recovery program" in the company's California offices (p. 19); the worker that works on the assembly line in iPhone and Apple Watch factories to sort waste (p. 17); and the automated disassembly robot Liam (p. 19). These waste roles, as defined by Apple, do not include those that sort through waste outside of the Apple supply chain. The text aims to interpellate the reader in the Apple network into the role of consumer. Thus, the associations between Apple and workers outside the supply chain are rendered invisible, and those between Apple and Liam (the more efficient, non-human recycler) foregrounded.

Apple argue that "a durable device is a greener device" (p. 27). Certified repairers and resellers are a group of actors with the role of fixing or redistributing Apple devices that have broken or are unwanted. By stopping such devices from becoming waste, their role is preventative in regard to waste. The *ERR* explains that Apple Care and certified repairers are the actors that have been enrolled within the network that fix devices. In representing this reality, the text inscribes a particular set of ideas about maintenance into Apple devices. When the Apple device reaches the end of its life, the company state that "the old ones often have new lives with friends or family, or in the refurbished market through programs like Apple Renew" (27). Other actors within the network that work to fix Apple problems, such as the website iFixit, which provides step-by-step instructions on home repair of the devices, are obscured within this process. Again, these actors are obscured because of their highly ambivalent role within the network. On the one hand, they provide services which keep Apple customers within the network, and these customers potentially purchase additional software and content. But they also threaten to destabilize the market for hardware. Purchasing an entirely new device affords Apple the greatest profit. Obscuring these actors once again is a way for Apple to continually generate sales and economic power. Additionally, it increases Apple's ability to define a role for the potential Apple customer, that of 'the environmentally minded' Apple consumer.

Through the *ERR*, and the nascent discourses of the circular economy, the potential Apple consumer is interpellated to 'ask less of the planet'. Purchasing Apple devices, and using Apple services is construed as the way to do this. The consumer is asked to dispose of the product correctly. When it is time to discard or resell the device, the best option is to do so through Apple's innovative, efficient, and environmentally sound take-back program. Although such a take back program is in many places legally mandated, such as in Japan, some US states, and Europe, the *ERR* focuses voluntary expressions of corporate social responsibility. It highlights many of the ways in which Apple has gone over and above mandated expressions of responsibility for the products they make, such as voluntarily removing harmful chemicals from their products "far beyond what's required by law" (p. 28). Such a focus gives the Apple product distinction in a crowded marketplace, and demonstrates Apple's environmental credentials. Empirical evidence, however, suggests that the overall increase in consumption afforded by cost savings associated with increased efficiency in smart phone recycling loses a portion of energy savings, and in some cases entirely eradicates them (Makov and Vivanco, 2018, p. 8). To prevent this occurring, demand must be reduced or stabilised (Zink and Geyer, 2017, p. 599). In this context, using environmentalism as a selling point potentially negates environmental impact they make.

The final role set out and constructed by the *ERR* is the 'institutional waste collaborator.' These actors are corporate or small government actors that Apple work with to achieve their broad goal of asking less of the planet, in this case through the reduction or elimination of waste. The company works with the city of Prineville, Oregon to use the city's waste water instead of fresh water to cool their data centre (p. 21). Apple argue that to eliminate, reuse, recycle, compost, or incinerate all the waste in their supply chain, this type of "collaboration across multiple Apple teams, local governments, and specialty recyclers" is essential (p. 19). To a degree, this is a fair statement. Advocating for atomized, individualized responsibility is not likely to bring about long-term changes to address the social and environmental harm electronic forms of waste produce (a theme explored further in chapter seven). Local government, along with central and international governance bodies in particular, have a crucial role in setting, and enforcing, frameworks to address these issues. Yet for Apple, however, such a statement is borne from a different politics entirely. Their argument suggests that ultimate responsibility for the waste that Apple create, that is, is never theirs alone. Further, by omitting larger, more powerful bodies such as national and international governing bodies from their list of potential collaborators the company are attempting to bring about a reality

where those that 'deal with' waste alongside them are too small to affect regulations, policy, and frameworks that would drastically change their practice.

Concluding Thoughts

The networks represented here reflect an assemblage of actors that have been arranged so as to provide power to Apple. By way of that representation, a particular reality is reflected and actors may choose to enrol in that reality. Such a representation reflects associations between actors including techniques, ideas, materials, institutions, and people that have been arranged as such that they strengthen the company. Often, this is done by making Apple an OPP, such as is the case with the "green" or "zero-waste" teams. The teams are reported as having been instrumental in "strengthening local recycling networks" and inspiring "other component suppliers who want to learn how to follow suit" (p. 19). More associations in which Apple is the OPP correlates with more actors to speak for, thus more power. Indeed, the company report that their focus on building these networks has increased in recent years. The *ERR* notes Apple are putting more effort into "inspiring others, influencing public policy, and contributing to improving global outcomes beyond the borders of our business interests" (p. 32). This has consequence for the conditions under which the associations between materials, ideas, humans, and energy that we consider waste here are performed into the future. Through the tracing of the waste networks being reflected and built in the *ERR,* then, I have shown how a particular reality in regard to waste has been inscribed.

This is not to suggest I have outlined a situation that is necessarily deterministic of future associations between actors. There is no guarantee that, over time, dissident actors may destabilize the network Apple is trying to build. The *ERR* does implicitly recognise that particular network structures Apple have used in the past have had environmental impacts that are not sustainable, causing harm in the form of energy use or the spread of toxins. In the next chapter, I explore this relationship further, suggesting that waste networks have to some degree played a role in the adoption of the zero-waste logics exemplified in the *ERR*. As we progress through the thesis to map the waste associated with the notebooks, this chapter has highlighted the waste-networks and actors Apple wish to render visible. In the next chapter, the focus shifts from the ideas that play a role in waste networks, to particular materials. Accordingly, the method employed switches to a follow the actors approach. Following the aluminium through the processes of extraction, production, and disposal constitutes the beginning of the construction of a map of a waste network.

Chapter five

The case of the casing: Aluminium waste networks and the notebook

In this chapter, I describe the network/s of relations built in the design, production, consumption, and disposal of the aluminium casing. I introduce the key actors, and highlight where these actors are involved in relationships that might be thought of as waste. The casing has been chosen for analytical focus because aluminium has been highlighted by Apple as a material with a significant environmental impact due to the toxic waste generated, and high energy consumption required, for its production. As covered in the preceding chapter, Apple have stated a long-term goal to be 'zero-waste', with the most high-profile steps toward this being the eventual cessation of mining. Their more short-term goal is to use more recycled aluminium. The trial resource recovery robot 'Liam' does not yet extend to the MacBook line, and it is not clear when recycled aluminium will be used with the product line. Mapping the network of waste that is associated with the casing nonetheless will provide a useful foundation to evaluate any future zero-waste strategy against.

I begin this chapter with an introduction to aluminium the actor, describing the qualities it has, and those it is afforded. I then look at how bauxite is mined and manufactured to become raw aluminium, before examining how it is transformed into a casing and assembled with other components. At every stage I examine the waste network that is being built. I use the concept of the black-box to show how power is maintained through scientific, technological and economic facts. I then move to considering the consumption and disposal of the casing. My own consumption of the casing is an intentional omission, as my own role in the broad network of waste as it relates to the notebook is covered in chapter seven vis-à-vis my relationship with the notebook's battery. I demonstrate how Apple use 'immutable mobiles' to maintain power and durability through time and Euclidean space. I argue that rather than eliminate waste networks, Apple's current recycling infrastructure creates new waste networks. Finally, I map examples of alternate waste networks, ultimately arguing that pitfalls arise within these attempts because, qua Cubitt, waste networks are integral to capital.

Designing aluminium cases

In 2008, Apple began using brushed aluminium for their MacBook range (Griffin, 2017, para. 5). Brushed aluminium is aluminium that has been polished to give a matte finish. Aluminium is the most abundant metal in the Earth's crust (Royal Society of Chemistry, 2017, n.p.). It is used in products from the mundane and everyday (aluminium foil) to the 'other-

worldly' (space travel). Consumer electronics are only a small fraction of the aluminium industry overall (Hotter, 2013, para. 8). The brushed metal has connotations of rusticity and minimal intervention, in comparison with its unpolished counterpart's notions of futurity and modernity. Thus, the brushed look epitomises Apple's brand aesthetic, the contemporary paradox of highly technical simplicity.

Design decisions, like introducing particular materials, create particular waste networks as they set the conditions for the production, consumption, and disposal of particular goods. Further, far from being a blank canvas on which meanings of modernity have been inscribed, aluminium has its own set of material properties. Aluminium is silvery-white and malleable (Royal Society of Chemistry, 2017, n.p.). When interacting with other materials, aluminium is resistant to corrosion, is thermally conductive, is non-magnetic, and non-sparking (ibid.). Chosen by Apple in part for its lightness and relative strength in proportion to weight, aluminium offers many desirable properties for a portable computing device (Apple, 2009, 1:24). Its low-density, for example, means that in comparison to materials like plastic aluminium casings are less likely to warp or deform. The lack of flexibility resultant from its strength does mean, however, that if the machine does receive a hard impact, it is more likely to dent than plastic (Crider, 2017, para. 5). Nonetheless, aluminium is easily cast, machined, and formed (Royal Society of Chemistry, 2017, n.p.). These properties of aluminium enabled Apple's development of a singular, moulded casing for their notebooks (previous iterations were comprised of different parts screwed together). This 'unibody' shape reduces the amount of parts needed, and streamlines the casing manufacturing process (Mead, 2008, para. 5). Further, aluminium is, by nature, highly recyclable, and can theoretically be recycled ad infinitum. It is worth noting that despite Apple's claims of the environmentally friendly nature of aluminium, Meyer and Katz found that in order for an aluminium enclosure to have less negative impact on human and environmental health than plastic, an aluminium notebook must contain more than 32 percent recycled aluminium (2016, p. 381). The streamlined, computer-controlled manufacture process afforded by aluminium, and its theoretically recyclable nature, are nonetheless qualities complementary with Apple's brand values of simplicity, quality, technological prowess, and environmental conscience.

Mining bauxite

Bauxite is the raw material used in aluminium production, and belongs to a geological network that pre-exists both the aluminium and notebook networks it is a part of. Considered a rock, it is comprised of aluminium oxides, aluminium hydroxides, clay minerals, and

insoluble materials like quartz *inter alia*. Bauxite forms through the "weathering of alumina-silicate rocks" over a time period spanning between a few hundred thousand and several million years (Ingulstad et al, 2013, p. 3). The process that transforms bauxite to aluminium is long, complex, and exceptionally energy intensive (ibid.). Building a bauxite-aluminium network also involves building a network comprised of relations of wasting. Such a network is characterised by processes of depletion, of careless and excessive use, and of harming and impeding other actors. It is possible that other materials could be used to produce aluminium, namely oil shale, clay minerals, power plant ash or alumite. These options would produce less waste, but as bauxite is abundant and relatively cheap none of these options are considered on a large scale (King, n.d., para. 11; Sheller, 2014, p. 16).

First discovered in 1821 in France, bauxite is most plentiful in tropical and subtropical regions (Ingulstad et al, 2013, p. 3). Australia, China, Brazil, Indonesia, Guinea, Jamaica, and China produce most of the world's bauxite today (Sheller, 2014, p. 16). Through the early twenty first century, the Chinese share of the global aluminium market rose from ten percent to over fifty percent (Knierzinger, 2018, p. 4). They are now the world's largest producer and consumer of aluminium, and half of their bauxite is sourced from Malaysia, despite periodic bans on exporting adopted by the Malaysian government (Head, 2016, para. 6, 15). Approximately half of bauxite by is mined by the 10 largest companies: a mix of multinational corporations and state-owned enterprises (Bell, 2016, para. 1).

Introducing a bauxite mine into a community reorganises networks of people, landscapes, animals, plants, practices, and ways of living. Large mining companies are powerful network builders. They enlist governments and others through the rhetoric of affording communities the chance to develop economically. A common strategy employed in enlistment is creating 'lack of infrastructure' as an obstacle problem. The mining companies can then offer to 'solve' this by building roads and providing employment. They employ a set of facts about national development that have been black-boxed, and came to be seen as self-evident. These black-boxes are networks that have been structured by actors such as international bodies like the UN, national bodies like governments, and knowledge institutions like universities. As networks are reorganised accordingly to these logics, a waste network is built. The new associations deplete the capacities of actor-networks and impede the functioning of actor-networks that comprise traditional ways of living (Sheller, 2014, p. 17). The black-boxed nature of the facts means that in many cases these waste networks are obscured. Despite their over-representation in the waste network, little profit is distributed to the communities

and countries surrounding the mine, even when the nation-state has close ties or owns the mining company (Knierzinger, 2018, p. 2).

Clearing a bauxite site entails displacement of people, deforestation, or both. Removing people from the land often displaces Indigenous people or small farm holders (Sheller, 2014, p. 17). Actor-networks comprised of people, land, animals, water, weather, and practices *inter alia* are broken or reorganised in such a way that their network expression (their traditional way of living) is severely impeded. Deforestation, removing large swathes of forest via cutting or burning, creates a waste network as it destroys habitats that were once hybrid actor-networks with diverse animal-plant populations. As biodiversity decreases, new associations form in the absence of the forest (Lee et al, 2017, p. 143). Roads are built. Soil and vegetation are cleared, in the process becoming part of the waste network as surplus to the requirements of the new associations (Lee et al, 2017, p. 137). Tools and machinery are bought in to drill and blast to liberate the rock now exposed (Lee et al, 2017, p. 140). Bulldozers separate bauxite from 'waste' rock (Global 3000, 2012, 1:20). As these machines come into association with workers, ergonomic injuries like hearing result (Donoghue et al, 2014, p. 512). This disrupting of normal human function constitutes wasting. Heavy metals such as cadmium, lead, and nickel, are unearthed during the process. As they are forced into association with nearby waterways, relations of wasting result when water quality is negatively impacted (Lee et al, 2017, p. 142). Large amounts of waste water are generated, along with other potentially hazardous wastes requiring treatment, storage, and disposal.

A new actor-network (red dust) develops, and waste arises in all the associations it enters into (Lee et al, 2017, p. 141). The dust contains heavy metals and other fine particulates, and settles on and in "every leaf, roof, and lung for miles" (Sheller, 2014, p. 18). For those living where the dust settles, the prolonged exposure to the dust has been linked with cardiovascular, respiratory, gastrointestinal, ear, nose, and throat problems as well as allergic reactions like asthma and eczema (Sheller, 2014, p. 14). Environmentally, the dust impacts soil quality by reacting with atmospheric gasses and altering soil chemistry, and dissolves in water, diminishing water quality (Lee et al, 2017, pp. 41-2). The dust settles in the vehicles and machinery of the mine, reducing their operating life and productivity (Petavratz et al, 2005, p. 1187).

Making alumina and red mud

Once mined, the bauxite is crushed and transported to a processing facility where it is turned into alumina (an aluminium oxide) through the Bayer process (Donoghue et al, 2014,

S12). Virtually unchanged since its inception in 1888, the Bayer process is the pressurized heating and cooling of bauxite in caustic soda (Ingulstad, 2013, p. 3). When this process is complete, aluminium hydroxide can be extracted from the solution that results, which is "calcined to form alumina" (King, n.d., para. 5). As not all of the components in the bauxite are soluble, a substantial and significant waste network arises from the associations of the Bayer process comprising the insoluble substance left over. This is known as red mud (Pontikes, 2005, para. 1). It contains fluoride, heavy metals, and industrial alkali, and has a high pH (Pontikes, 2005, para. 1-10; Liu and Naidu, 2014, p. 2663). For each tonne of alumina produced, depending on the exact process used, between just under one and two tonnes of red mud are generated (Zhang, Zheng, and Zhang, 2011, p. 827; Liu and Naidu, 2014, p. 2663).

Red mud is a material largely surplus to the requirements of industry. It is incredibly abundant. In China alone there are 60 million tonnes in storage (Liu, 2015, p. 5). Advocacy group Toxic Leaks suggest this figure may be as high as 90 million tonnes (Toxic Leaks, 2017, para. 4). Owing to its composition and high alkalinity, red mud has the potential to negatively impact human and environmental health. Red mud must be neutralised before storage or re-use (Liu, 2015, p. 22). Thus, storage is a relatively expensive and dangerous process. Most red mud in existence is currently stored in deep-sea trenches, in unlined and dammed ponds, in lined and drained ponds, or stacked as a dry mud (Persaud, 2008, p. 5). Owing at least in part to the pitfalls of storage, there is an increasing drive to reconsider red mud as a source of economic value. Alternate uses for red mud include treating it to recover caustic soda before putting it to reuse in rubber, plastic, cement, bituminous roading, bricks or other building elements (CSIRO, 2016, para. 6; Kurdowski and Sorrentino, 1997, p. 294, 299). China have set a target to reuse ten percent of their red mud, and it is used in low amounts as a raw material in the European construction industry (EPA, n.d. para. 7; Stanford, 2016, para. 16). Due to toxicity concerns, the reuse of red mud is banned in the US (EPA, n.d., para. 6). Globally, however, the US Environmental Protection Agency report that only two to three percent is actually reused as described above, likely due to the cost of working with the substance (n.d., para. 7).

As these various government approaches show, in comparison with other waste networks described in this chapter, waste mud is 'officially' considered a waste product. Its material presence is governed to some degree by policy. This governance structures the network of associations that the insoluble product can enter into. Insofar as red mud spills and leaches, this governance will never entirely determine its fate. Similarly, as red mud is stored as a cost saving exercise, it is enlisted in a role that provides economic power to those who are spared the larger cost of redeveloping it. The mud's exchange value, a symbolic representation

of its place within an actor-network built by the black-boxed concept 'the market,' plays a role in governing what happens to it. Yet as with policy governance, this is never entirely deterministic of how red mud will act. In the interactions between the mud and the actors around it, the elements, pond linings, human error, and so on, there is always the potential that the governing power of the market will be destabilised.

Making Aluminium

As with bauxite, producing alumina also produces a waste actor-network that is both pervasive and harmful. Producing aluminium from alumina is done through the Hall-Heroult process. In this process, alumina is first dissolved in a molten cryolite bath (King, n.d, para. 5). Cryolite is an aluminium compound comprising of sodium, aluminium, and fluoride that has a comparatively low melting point (BBC, 2014, para. 3). This cryolite-alumina substance has a current passed through it. During this process, the electrolysis drives a chemical reaction where pure aluminium is attracted to, and collects on, the negative electrode (BBC, 2014, para. 5). The Hall-Heroult process produces harmful waste gasses. Molten cryolite releases fluoridated gasses which contain greater global warming potential than carbon dioxide (OECD, 2010, p. 34). Fluoride emissions lead to waste in the form of environmental harm. The Hall-Heroult process arranges associations between actor-networks that are represented symbolically by the term environment in such a way that depletion, degradation, disruption to or impeding of 'normal' functioning results. When fluoride particles from the molten cryolite, for example, came into contact with forestry near a Russian smelter, millions of hectares of Scots Pine trees died as a result (Wiedersteinas as cited in Knierzinger, 2018, p. 8).

The Hall-Heroult process is one of the most energy intensive industrial processes in existence (Knierzinger, 2018, p. 7). In the US, for example, between two and five percent of all energy generated goes toward the process (Royal Chemistry Society, 2017, n.p.). It follows that aluminium production also often occurs in locales where electricity is cheap. Cheap electricity often correlates with coal, which generates large amounts of emissions (Paraskevas et al, 2016, p. 212). Where coal is not used, hydroelectricity is common. The process of constructing a hydroelectric dam has considerable environmental impact. Aside from deforestation and forced migration, the emissions footprint of a dam is high, because flooding the land fuels microbial decomposition, "converting organic matter stored in, above, and below ground biomass to carbon dioxide, methane, and nitrous oxide" (Deemer et al, 2016, p. 949). Apple do not currently use recycled aluminium in their MacBook range, nor have they publicly announced their plans to do so in the future. They themselves recognise that aluminium

contributes a significant portion (24 percent) of their emissions footprint (Apple, 2018a, p. 16). The solution they employ is to prioritise hydroelectricity alongside reincorporating their scrap aluminium (ibid.). My notebook is thus connected to the waste-networks described here, and these connect the relatively micro-network of the notebook to much larger global networks associated with climate change.

Making a case

The bauxite and aluminium networks described above were not built by Apple. Apple have, however, organised and structured the actor-network responsible for making the notebooks case. Transforming a sheet of finished aluminium into a notebook casing, and assembling it with other components, involves the enrolment and translation of many actor-networks that Apple come to speak for. These actor-networks also include diverse waste actor-networks, such as spent cutting fluid (an actor-network of oils, synthetic chemicals, pH regulators, corrosive protectants, biocides and anti-foaming agents), aluminium off-cuts, and workers that have their health and safety compromised. Catcher Technology were enrolled to mill the aluminium into the casing shape. A long-time supplier of Apple, they have been making casings for notebooks since 1994. In 2011, they produced more than half of Apple's casings (Slivka, 2011, para. 4). Although a Taiwanese company, Catcher also have factories in China (Catcher, 2012, para. 1,4).

Like many electronics industry suppliers, Catcher have a notoriously poor record in regard to worker health and safety and environmental violations. In other words, they structure the conditions their workers act within by organising the actors they are able to associate with in such a way that impedes upon their basic human rights. Recently, for example, reporter Peter Elstrom reported a lack of showers or hot water in their Suqian factory (2018, 1:12). Around the time that my particular casing would have been produced by Catcher, one of their Chinese factories was forced by Chinese authorities to close down for a month. The closure was reportedly due to local residents complaining about a noxious and unbearable smell (Reuters, 2011, para. 2). At the companies Siquan plant, cutting fluid and oil used in cleaning regularly entered waterways as the fluids were tipped down the drain (CLW, 2018, p. 19). Whilst no official investigation has been carried out in this case, in 2013 RiTeng, another Apple supplier was charged with illegally discharging waste water containing oil and cutting fluid into a nearby Shanghai river (Kan, 2013, para. 1-4). The river was temporarily coloured white, an indicator of harm to the actor-network (ibid.). As with bauxite mining, materials are being associated in a way that produces waste networks.

Creating a notebook casing involves starting with a solid block which is extruded to the desired thickness, before being machined and milled into shape under computer control (Apple, 2009, p. 135). Surplus aluminium is reportedly recycled, the environmental effects of which are discussed below. The advocacy group Chinese Labour Watch (CLW) noted that in one of the company's plants aluminium-magnesium alloy shavings were stacked in such a way that they regularly washed into storm water by the rain, or blew off (CLW, 2014, p. 18). The presence of aluminium impedes the function of many actor-networks that water plays an important role in, thus the shavings entering the water constitutes a waste association. Even when the shavings are stored correctly for recycling, extreme care must be taken as oxidation reactions occur when the shaving come into contact with an ignition source, resulting in fire. The smaller the aluminium particle, the greater the risk of potential combustion (Maoling, 2012, p. 516). The waste network of associations that result in harm and depletion of actor-networks as related to aluminium dust is exemplified by two factory fires occurring at Apple assemblers Foxconn (May 2011) and RiTeng (December 2011). These fires caused injury, one death, and the loss of materials.

CLW report numerous incidences of inadequacies in Catcher's deployment of employee and environmental protection measures. For example, a waste network resulted when in 2012 a chlorine gas leak occurred during waste treatment in a Catcher factory in Eastern China. The leak meant chlorine associated with workers with the result of one person's death, and seriously impeded health of four others, who were left in comas (Reuters, 2012, para. 1). The cutting fluid used in the milling process regularly associates with human other actor-networks as it spills and splashes, producing the waste effect of harm to human functions like sight (CLW, 2014, p. 19; Fuchs, n.d., p. 5). When the chemical comes into association with plastic protective equipment the resultant association is one of erosion. This leads an association between human skin and cutting fluid, which results in skin irritation (CLW, 2018, p. 7). Catcher employees work long days in these conditions. There are no effective unions, a deliberate attempt to maintain network structure by preventing workers entering into associations that destabilise the network effects (profit) generated by the current configuration (CLW 2013, 2014, 2018).

When the case is complete, it is assembled with other parts into the notebook. There is always competition for lucrative, large contracts assembling Apple products. Apple looks for suppliers that offer low prices, fast time to market, and quality control (Chan et al, 2013, p.102). My MacBook was assembled in Shanghai in early February 2012. During this period, Apple were diversifying their supply chain away from supplier Foxconn. Two factors likely

contributed to this. Firstly, in 2011 and early 2012, there was a spate of suicides and a riot amongst Foxconn workers. Foxconn, and by association Apple, were regular subjects of negative press (Dou, 2013, para. 7). For Apple, the negative media attention on parts of their supply chain was likely undesirable. For the workers affected, poor working conditions, low pay, exposure to occupational hazards, a largely migrant workforce and inadequate training all contributed to these events (Chan, Pun, and Selden, 2013, p. 100).

Secondly, according to the *Wall Street Journal*, Pegatron indicated they were willing to accept thinner profit margins (potentially capitalising on Foxconn's struggles) (Dou, 2013, para. 6). RiTeng, a Pegatron subsidiary in Shanghai, likely was the site of assembly (CLW, 2013, p. 2). The thinner profit margins accepted by RiTeng were likely one factor that contributed to the way they organised their business. In this factory, overtime violations, insufficient training and meal breaks, poor living conditions, and discrimination were rife (2013, p. 50). CLW allege underage labour was used, under the guide of internships for high school students. These workers worked just as long as the adults, but often had their pay docked to pay a fee to the school that sent them (2013, p. 1, 3). This actor-network then produces a waste effect insofar as it impedes workers' sense of freedom, personal autonomy, and basic human rights (2013, p. 58).

The waste networks that we have seen in this chapter so far are structured by powerful actor-networks. These networks are as diverse as the waste they make, comprised of ideas, companies, practices, governments, algorithms and individuals *inter alia*. Whilst they are all important, perhaps most notably highlighted by this chapter have been actor-networks of ideas related to economics, development, and profit. As Cubitt points out, these networks are never solely human: they are hybrid actor-networks of non-humans and humans (2015, p. 139). Human intention can be understood as a key factor in organising networks, but cannot be the sole factor.

What is made clear by following the actors as bauxite is performed into aluminium, and as aluminium is performed into a casing, is that waste arises as a consequence of particular ways of ordering networks. Waste here is a by-product, albeit with very diverse compositions. Yet, this explanation feels doubly inadequate to describe the actor-networks that embody relations of wasting. Firstly, these waste networks make particular network structures possible. Cubitt notes that "without waste… there can be no consumer capital" (2015, p. 141). Similarly, without waste there could be no networked information capital, at least in its current formation. Secondly, these actor-networks enter into associations with other networks, with the result of creating entirely new actor-networks. Waste, then, is not inert. Chemicals leak. Workers riot.

Emissions associate with other atmospheric actor-networks and contribute to changing the climate. All of these events have associated to such a degree that they have come to have some degree of power structuring the networks that originally structured them. As we saw in the previous chapter, Apple minimise the impact these networks have to maintain their power. In the next section, as I follow the actors through the processes of disposal, I begin to analyse whether Apple's attempts to minimise waste are more than just symbolic.

Recycling a case

Following assembly, the notebook made its way to me, via a retailer. This section considers two options for what might happen to the casing once it leaves me: reuse or recycling. Recycling may be Apple mandated, or carried out by a non-approved Apple recycler. Whilst presented as distinct paths, in actuality there are associations between the two in the network. Should I choose a recycler not approved by Apple, there is a good chance that the device will be repaired and reused, even if it enters the 'informal[3]' recycling sector (Lepawsky, Goldstein and Schultz, 2015, para. 33). This is because repair is far more profitable than material extraction (ibid.). Because the informal sector can make greater profit repairing, it means they are able to offer higher prices for e-waste than the formal sector (ibid.). Apple, as mentioned in the previous chapter, suggest that many of their users simply gift their old Apple product to a family member before upgrading. It makes sense this is the most desirable option for Apple. A strong market of second-hand MacBooks may weaken the desirability of the Apple brand, and reduce demand of new MacBooks (Hruska, 2017, para. 8). Whilst Apple does not offer a trade in or end-of-life purchasing service for MacBooks in New Zealand, many other service providers do. These companies may refurbish the device themselves, and resell within New Zealand, or send overseas to be repaired, refurbished, and resold. Even in a broken state, the notebook contains many parts that are useful, and scarce enough to create demand.

Whilst they do not currently offer reimbursement for the notebook, Apple will recycle it on my behalf. In New Zealand, this is administered through third-party recyclers InfoActiv. Taking this step involves filling out a form with my contact details, and at the same time relinquishing any rights I hold as owner. InfoActiv then work with me to arrange a courier to pick the item up. It is preferred that I have the item packaged for sale, which incurs a small cost to the consumer (InfoActiv, email correspondence, March 9, 2018). The notebook will

[3] Informal' refers to the practice of illegally recycling electronics, often through the export of electronic waste from developed countries to nations that lack a developed recycling infrastructure.

then be processed according to Apple's "internal mandate for data security and sustainability (InfoActiv, email correspondence, February 22, 2018). Apple actively use such policies as an immutable mobile, a knowledge technology that enables them to remain in control despite significant geographic difference over the actions of those enrolled within their network. Within the US, an investigation by journalist Jason Koebler found that the company has a "must shred" condition that applies to the third-party recyclers that collect for it (2017, para. 8). This means that Apple devices are not to be salvaged once collected, to maintain control of their market-network by preventing a second-hand market developing. Policies like this constitute strategies that maintain the control of Apple within the network, a way to keep actor-networks expressing their will despite distance.

As a distinct commercial and manufacturing activity, aluminium recycling began less than 20 years after the commercialization of the Hall-Heroult process (Green, 2007, p. 109). 'Recycling' can be considered a black-box. The benefits of recycling are seemingly self-evident; the energy savings of the aluminium recycling process are great, and to recycle 10 kilograms of aluminium is over 90 percent more energy efficient than mining, as well as reducing the creation of carbon and sulphur dioxides (Electronics Take Back Coalition, 2014, pp. 7-8). The black-boxed nature of recycling elides its controversial, undetermined aspects. It must be noted, then, that aluminium smelting is exceptionally energy intensive in the first place, and even with these savings it still is an energy heavy process.

When recycled, aluminium is first shredded, before being separated from other materials through the use of an eddy current. It may be further liberated from other alloys like magnesium, sodium, or calcium through smelting and separating (Green, 2017, p. 116). Although this process can be repeated ad infinitum, entirely separating out other materials is difficult and has only recently became feasible, and so aluminium becomes progressively impure each time it is recycled (ibid, 109; Norsk Hydro, 2015, 1:00). When aluminium is smelted with other materials, because of incomplete or no separation, it is not easily recovered (Gui and Zhang, 2008, p. 235). Further, being alloyed with aluminium can degrade other materials (Norsk Hydro, 2015, 4:00).

Finally, recycling is a dangerous industry. Even in developed countries, it relies upon dangerous heavy machinery including shredders, furnaces, grinders, and conveyer belts (Joseph, 2016, para. 11). This is true for aluminium, and there is the added risk of molten metal explosion (Green, 2007, p. 130). Further, when aluminium recycling is carried out in informal workshops, without adequate personal protective equipment and safety protocols, the risk to

harm for the workers is higher. These harms and risks constitute waste. Rather than prevent wasting, that is, recycling creates new ways of wasting.

Recycling as a waste network

In the preceding chapter, I showed how the *ERR* both reflects, and is a strategy to enrol, people and objects into an actor-network built by Apple. To assemble the casing, Apple have enrolled yet more actor-networks, gaining power by making themselves a point of obligatory passage. Becoming an OPP means that other actors have to come into interaction with Apple, or those that it speaks for. This does not mean that actor-networks necessarily enter into the association willingly, with intention. A farmer whose water source has been contaminated by chemicals in storm water from an Apple assembling factory upstream certainly has not chosen to be associated with the network. A powerful actor like Apple will influence how the farmer acts by determining the contours of the actor-networks that the farmer comes into contact with. The farmer might be considered enrolled in the Apple actor-network. But this does not mean her position there is permanent. She will continue to associate with the human and non-human actor-networks around her. Some of these networks will be entered into with intention, and others by association. The effects provoked by such associations are inherently unpredictable.

The workers that carry out informal recycling provide a good example of workers enrolling in networks of waste, despite it involving them in relationships where they are harmed. It is worth noting here that while Apple is a powerful actor in these networks, it is not the network builder per se when it comes to broad waste networks. I would argue this network is built by the black-boxed actor-network 'the (capitalist) market'. Workers enrol in these 'informal' waste networks in response to their economic situation. Put differently, the associations between the workers and surrounding actor-networks are structured and arranged largely by a set of economic facts and regimes of value that have been 'black-boxed' as a self-evident reality. Apple actively work to set conditions within the network in their favour, such as actively suppressing legitimate second-hand markets for their products, and thus do considerably affect these actors. At the same time, the conditions they operate within are also set. The fate of any actor-network by way of this position is by no means sealed. Thus, the waste networks built by Apple and the ICT industry more broadly are not fixed arrangements. They can be rearranged into 'alternative waste networks.' These are networks in which the actors are arranged differently, to mitigate the negative incidences of harm and depletion. Such attempts will not necessarily be successful. The following examples highlight why this may be.

When attempting to rearrange waste networks, one reason that academics and NGOs are not always successful is that those working and living everyday with e-waste perceive their experiences differently. In 2017, for example, a study by Yu et al found that while workers at Agbogbloshie[4] did connect specific health ailments such as physical and eye pain to their work, they generally did not associate health concerns with their work (2017, p. 93). All of the 20 workers interviewed expressed the desire to find more stable and skilled work, and the authors noted that work in the informal sectors provides them with the capital needed for an eventual move to another occupation (Yu et al, 2017, p. 95). In a similar study in Ghana, Agyei-Mensah and Oteng-Ababio found substantial differences between workers', academics', and NGOs' perception of illness and environmental harm caused by e-waste picking (2012, p. 513). Academics and NGOs tended to rate health and environmental harms much higher (2012, p. 513). This difference in perspective can be explained in various ways. As per Stowell and Warren, pain is made sense of socially. As workers share their experiences, they come to be understood not as pain, but as everyday reality (2018, p. 787). Taking a different approach, the ecologist Robert Paine has argued that a coping mechanism in the face of adversity is to minimise or 'play down' risk (2002, p. 86). It may also be that the economic benefits of informal recycling have been downplayed by academics and NGOs working to put an end to the practice. Agyei-Mensah and Oteng-Ababio note that a higher income correlated with less perception of harm (2012, p. 512). These examples, I argue, suggest that a pre-requisite for any network being built to restructure networks to prevent the worst associations of wasting must be that it is built primarily by those most impacted. This does not mean that 'outsider' knowledge about risks to health and environment will not be enrolled, but it means that knowledge needs to be controlled by those affected.

This next example details a very public attempt by the Chinese government to build an alternate waste network of formal recyclers. Facing public pressure from within and without China, the Chinese government launched 'Operation Green Fence' in 2013. As part of this campaign designed to halt the importation of illegal and contaminated waste items, China became more stringent in blocking imports of e-waste (the transboundary movement of which is illegal under the Basel Convention) (Mi, 2018, para. 4). In 2015, the Circular Economy Recovery Park was opened near the town of Guiyu, China. The park was opened to address pollution as a result of e-waste recycling in the town, as well as provide officials the chance to

[4] A large open dump in Ghana, where waste pickers work recovering materials from discarded electronics.

screen e-waste for foreign shipments (Recycling Today, 2015, para. 2). The town of Guiyu had been the focus of international attention led by advocacy groups like the Basel Action Network as a result of a large, informal e-waste recycling industry in the town. When the park opened, the town's informal electronic recycling workshops moved in.

The introduction of the park did rearrange waste networks, but it is less clear as to whether it actually mitigated the incidence of harm. Chen Xinrong owned an informal recycling work shop in Guiyu from the 1980s, and was one of the first villagers to make the move from farming. He specialized in dismantling hardware and selling aluminium to be used in doors and windows. For Xinrong, it was a successful venture that enabled him to live a comfortable life. As importing foreign, higher quality waste became harder, business became more difficult. When he moved into the park, he claims his business shrunk from six employees to two. This is largely due to there now being no foreign imports. Whilst the park has led to the cleaning up of the environment, which Xinrong notes is a real positive, it has also decreased the amount of revenue workshops make. Resident Yang Linxuan shares this sentiment, and notes that while the environmental impact of recycling is mitigated, there is no change in recycling technique, so there has been no positive impact on human health (as cited in Pinghui, 2017). Perhaps unsurprisingly, given the network has been built by the notoriously opaque Chinese government, anthropologist Yvan Schultz notes that not a lot is known about large formal recycling sites like at Guiyu. They are difficult for researchers to access. Further, informal recycling, which is reported as still occurring in some locations throughout China, has been stigmatised as a result of advocacy attempts (Williams, 2017, para. 17). This makes informal recyclers less likely to share their stories. Whilst formal recycling in China is constructed as the environmentally and socially desirable option, this is not yet conclusively proven to be the case (Schutz as cited Leijonhufvud, 2013, para. 5). When attempts are made to create alternate networks that eliminate or mitigate waste, as this example suggests, there is the risk that instead of disassembling waste networks and the harm that results from them, the associations are reinforced or rearranged. In either case, harm results.

Concluding Thoughts

Apple's zero-waste economy, and the circular economy more broadly, presumes that through rational and responsible action informed by science performed by corporations, government, and consumers alike, the goal of a zero-waste, profitable economy is possible (Gille, 2010, p. 1054). In other words, with the right application of innovation, science, and technology, nature, bodies, and materials can be arranged in such a way that they will produce

any given effect (ibid.). To a degree, this is true. As we have seen here, powerful network builders have extensively used science, technology, and economics in constructing their networks. Currently, the consequence of this is the co-construction of a vast waste network. This network includes actor-networks classified 'officially' as waste like red mud, as well as expressions of harm, degradation and depletion not generally considered wasting. In this category are the decline of hybrid actor-networks associated with traditional indigenous ways of life, water contaminated with heavy metals from mining and production processes, and workers whose basic rights and human functioning are impeded by the roles they are enrolled into as part of notebook production. I have argued in this chapter that these waste networks are integral to capital. Waste makes Apple's current formations possible, and plays a role in restructuring their networks. Whilst this case study has been specific to the MacBook, insofar as aluminium is used in a variety of other products, the findings here are largely generalizable.

It remains unanswered as to whether these same powerful network builders are capable of building zero-waste networks, even within Apple's comparatively limited definition of zero-waste. Two key issues in regard to this have been raised by this chapter. Firstly, Apple exercise control within their networks through the use of immutable mobiles, such as the recycling policies described in this chapter. Setting supply chain policy, as we saw in chapter one, is employed to realise the zero-waste goals. Yet the associations mapped here present a waste network that looks very different to the one Apple introduce in the *ERR*. Further, as the attempts to circumvent waste documented here show, efforts to ameliorate waste networks often simply reorder them. Despite the promise Liam suggests, there is little concrete evidence that Apple's recycling policy will not displace waste networks in the same way. The associations and thus overall expression of wasting may be different, but nonetheless waste still result. Secondly, that Apple do not have control over all of the processes within their supply chain suggests at the difficulty inherent in implementing a circular economy more broadly. The current extractive economy is configured as it is not just because of human intention, but because of a host of market algorithms and other actors with immense power in shaping how companies and industries act. As material actors like red mud, and human actors like the Agbogbloshie workers demonstrate, actors will act in ways that are unexpected and complete and final control is impossible. In the next chapter I build on this idea to explore the politics of building an alternate network, picking up my earlier argument that how networks are described matters. As the preceding chapter argued, discourse (including scholarly discourse) always reflects and constructs reality. Apple, in this chapter have been presented as a powerful actor-network, and a comparatively powerless actor-network. This analysis is built upon in the next chapter.

Finding spots within the waste networks where Apple's power is weak, as was demonstrated here in regard to informal recyclers, becomes a key strategy in answering the question 'how do we circumvent waste'?

Chapter six

Between a rock and a hard disk: Waste networks, workers, and researchers

The HDD is one of two locations in my notebook for storing information (the other location, 'Random Access Memory', stores information on silicon chips for retrieval while the computer is on). Building on the idea that design decisions are crucial in the formation of waste networks, in this chapter I first introduce the original network builders, the 'inventors' of the HDD and the broader industry network that they are implicated within. Secondly the Head Gimbal Assembly (HGA) provides a case study to exemplify the HDD construction process. HGA is a sub-process of HDD head construction (Mak et al, 2014, p. 1155). Thirdly, I look at how neodymium, a crucial component in HDDs, ICT equipment, and sustainable technologies more broadly, is extracted. In doing so, I discuss the HDD industry's implication within a wider economic network. Each of these three strands of analysis reinforce that waste networks are a necessary co-construction when network builders arrange associations to increase their power. As in the previous chapter, the expressions of waste that arise from these associations are characterised to harm to both human and environment. The descriptions offered here highlight the urgency of the task of breaking waste networks. Yet as with the case studies in the previous chapter, rearranging the associations of waste networks to mitigate harm is a fraught process. I demonstrate here that as researchers and activists come together with those affected by the network of waste a shared experience is created. This shared experience potentially reinforces or reinscribes harmful waste relations. Ultimately, I argue that this highlights a need to change the way we understand waste networks, from something that can be controlled, to something we are inherently a part of.

The HDD

The HDD stores information as minute, concentric tracks on the surfaces of disks. Each HDD may contain one or more disks (platters). These disks are made from glass or aluminium substrates, and are coated with many layers of magnetic film. The disks are spun by an electric spindle motor. Each platter has a read/write head attached to an electromechanical arm (Woodford, 2018, para. 5). The head magnetises tiny sections of the film, and stores that data as a 1 (positive charge) or a 0 (negative charge). These binary digits are 'bits', which comprise codes corresponding to numbers and letters (Woodford, 2018, para. 4). A square centimetre of the disks surface contains billions of bits. The physical movement of the arm is controlled by an aluminium actuator comprising copper coil and a central ball (Chen et al, 2006, p. 3).

Neodymium magnets drive the arm to make incredibly small and precise movements (Allen-Robinson, 2017, p. 459). A circuit board mediates the transfer of electricity and information between the computer and the HDD. This circuit board is located either in the drive itself or the computer's main circuit board ("PCB Swapping" 2014, para. 2). The head is directed to where to read or write information by a map of the tracks contained in chips on this printed circuit board. In my particular HDD, the board has various chips containing information crucial for the drives operation ("PCB Swapping" 2014, para. 3). The physical positioning of the head itself is controlled by a servo mechanism, which uses a signal to determine deviation from a centre line to determine position. It carries out track seeking (getting the head from one area of the disk to another in the least amount of time possible) and track following (keeping the head as close as possible to the destination track centre as information is read from or written to the disk) (Chen, 2006, para. 3).

Building a HDD network

As devices get smaller the HDD is no longer the most commonly employed storage option in consumer electronics such as notebooks or phones. Instead, the solid-state drive (SSD), which stores information on silicon chips is the nascent storage mechanism for personal electronic requirements. The HDD is now more commonly found as a means of storage within data centres. In 2016, data centres were the largest market for the HDD (Brewer et al, 2016, p. 2). This trend is expected to continue (ibid.). The HDD is nonetheless considered a relevant entity to study, because use in data centres means the HDD will continue to play an important infrastructural role.

In 1955, IBM unveiled the prototype for the modern HDD. It had a read/write head which glided over a bumpy surface giving it random access to five to seven million bit characters. Since its inception, the amount of data able to be stored on a HDD has increased more than 1000 000-fold, and is physically 10 000 times smaller (Mak et al, 2014, p. 1155). The HDD network built by the IBM designers, working in a larger network built by IBM, were part of a nascent Silicon Valley technological industry driven, in part, to service the needs of the US military. Rather than a sole achievement of the IBM designers, a large number of actors participated in the invention of the HDD. Any sort of innovation requires the presence of people and institutions (like universities, government departments, and private research laboratories) to develop and progress knowledge (Dedrick and Kramer, 2015, p. 1617). Nonetheless, the IBM designers can be credited with setting very defined and precise roles for a group of actors that form the HDD network. Within the HDD network, the designers (and the larger networks

they were a part of – IBM, the nascent Silicon Valley culture, and so on), inscribed into the HDD their past experiences with information storage, their belief systems, moralities, and visions for the future (Law, 1992, p. 208). Particular materials were enlisted to act in specific ways as a reflection of these designers' assumptions about how technology and the economy would evolve, and about the gap the product was imagined as filling. Such assumptions, in turn, create a role for the user, who acts under conditions set by these network builders.

Building Waste Networks

The modern form of the HDD is indebted to research carried out by IBM in Silicon Valley (Fisher, 2001, para. 14). As the researchers and designers worked, they created an extensive network of waste which connects to a larger waste network constructed by the activities in Silicon Valley. When research relating to HDDs is carried out, for instance, it requires exceptionally clean environments, vast amounts of energy for heating and cooling, and the use of toxic chemicals that have specific disposal requirements. The specific factory early HDD's were made in has a history representative of the history of the computing industry more broadly. A waste network was built by the research carried out here, a network characterised by human and environmental devastation. Many chemicals with varying degrees of toxicity were enlisted into roles within the HDD network. As network builders, the researchers were themselves acting within conditions determine by economics and other factors. These researchers could, to some degree, control how the chemical actor-network expressed itself. They could not determine in entirely the associations these chemicals entered into. As these chemicals entered into association with workers and with surrounding environments, associations of wasting unintended by the researchers arose.

Yet actors representing IBM and the industry more broadly, such as the IBM staff doctor and the Semiconductor Industry Association, concealed the nature of these expressions, arguing that the site was safe for workers and surrounding communities (Fisher, 2001, para. 44-5). IBM's own worker mortality statistics indicate a rate of cancers higher than normal (Fisher, 2001, para. 9). Industrial solvents, such as Freon and trichloroethylene, leaked from the IBM factory where the disks were first made, coming into association with the drinking water of 65, 000 near-by residents (Pimental, 2004, para. 13). For these residents associated with the water, the result was an expression of wasting in the form of a higher than average rate of birth defect and miscarriage. Yet no direct link between this and the leaks was officially made (Pimental, 2004, para. 34). As demonstrated in the previous chapter, economic discourses

around cost saving and increased profit have a disproportionate impact in structuring network associations so that waste results.

The waste networks associated with the HDD exemplify the process of 'official denial' through which specific actors are made invisible. As Peter Little argues in relation to Endicott, another IBM site of environmental and human poisoning, the process of official denial works by rendering particular scientific facts as unbiased and true. In a neoliberal governance context, those tasked with arbitrating such cases quantify risk and harm based on these facts, neglecting the context 'truth' is constructed in. Such facts are "the outcome of a social and political economic reality conditioned by production, construction, and competing forms of representation" (Little, 2014, p. 28). Particular actors become invisible through this process, left out of such official accounts. Arranging networks so that particular actors are excluded from official narratives benefits powerful actors, namely government and members of the semiconductor industry. It mitigates the delegitimising effect on their power facts associated with human and environmental poisoning have.

Globalisation of waste networks

In early years the HDD industry was dominated by American firms. Economically, it still is. Production often occurred within America, implicating US citizens within waste networks. Physical production and much of the waste network moved offshore in the early 1980s. The industry is now predominantly physically located in Thailand, Malaysia, the Philippines, and China (Hiratsuka, 2011, pp. 7-8). How HDD producers and suppliers interact within the supply chain is driven by geography, economics, and cultural logic. Japanese companies tend to use more home based or Japanese affiliated suppliers. American companies are more likely to use indigenous suppliers, assemblers, and labourers (Hiratsuka, 2011, p. 12).

Historically, the HDD industry has been a site of fierce competition. Many producers have entered and exited the market. Acquisitions and mergers are a common method for gaining power within the HDD supply chain. American multi-national technology companies (like Apple or Seagate) often invest heavily in start-up parts suppliers. Enlisting actors into the network this way provides power to network builder by giving them the ability to define the supplier can act, by securing exclusive access or dictating who they can sell to (Emerald Group, 2015, p. 2). The way that companies perform in regard to ability to offer low prices, time to market, time to volume production, and yield improvement have also been instrumental in determining success or failure within the industry (McKendrick, Doner, and Haggard, 2000, p.

17). As Holt and Vonderau point out, it would be naïve to presume such techniques give any company complete control of a supply chain (2015, p. 33). Nonetheless, they do substantially increase their power by way of influencing how actors within the industry act.

Whilst the factors correlated with success no doubt influence the waste roles that are created, implication with waste networks has not influenced success. In 1991, Seagate were accused of poisoning workers between 1990 and 1991. Four workers died after exhibiting symptoms similar to poisoning from the solvent Freon (Forsyth, 2002, p. 216). 36 percent of workers at the factory were found to have higher than usual amounts of lead within their blood (Forsyth, 2002, p. 214). Although never conclusively proven, the case was widely publicised internationally and drew the threat of sympathy protests from other unions in Thailand (Forsyth, 2002, p. 215). The Thai government, worried that the technology industries would move their business offshore, were slow to act. Seagate were accused of moving staff between departments and factories to prevent all exposed workers being tested (ibid.). A body set up to investigate was closed down before a conclusive report into the circumstances of the workers deaths was released.

Head gimbal assembly

As the Seagate saga shows, producing HDDs is an intensive and potentially dangerous endeavour. The HDD in my notebook was assembled by Japanese company Toshiba, in the Philippines. Toshiba entered the Philippines after other Japanese multinationals, and smaller parts suppliers followed them (Tecson, 2006, p. 232). Toshiba are themselves a manufacturer of notebooks. In 2017, *Ethical Consumer* website rated them amongst the 'worst' technology companies based on the management of human rights and environmental issues within their supply chain. The networks within the Toshiba HDD supply chain regularly shift, so determining the exact company that supplied the parts in my particular hard drive, where those parts came from, and the nature of the waste network built can be difficult. However, as many smaller Japanese suppliers moved in to the Philippines, it is likely that the suppliers were Japanese-owned enterprises also working in the Philippines such as Nidec (motors), Luzon Electronics Technology (slider and HGA), and Tsukuba Philippines Die-Casting Corporation (Tecson 2006, p. 232). For that reason, the following analysis focuses heavily on conditions in the Philippines (nonetheless indicative of broader technology sector conditions in wider South East Asia).

The HGA process begins with the construction of semiconductor like silicon wafers, which are machined into small rectangular 'sliders' that will eventually glide over the disk to

read and write information (Dedrick and Kramer, 2015, p. 1617). The silicon itself is mined from ferrosilicon, an abundant resource, in a process that does not generate tailings (Grossman, 2006, pp. 36-7). Mining silicon is considered to be less environmentally damaging than the mining of other materials (like aluminium). Creating the chip begins with silicon dioxide, which is ground and distilled before being heated, reduced, cleaned, reheated, placed into quartz crucibles, and grown into crystals (ibid.). The silicon must be incredibly pure (Intel, n.d., p. 10). The crystals are then heated again to liquid, before being cooled into a solid crystal cylinder called an ingot (ibid.). The ingot is then sliced to form wafers, which are ground and polished until "flawless" (ibid.).

The process is exceptionally resource intensive. It takes 9.4 kilograms of silicon to make one kilogram of wafers, generates waste water high in nitrates, uses many chemicals that are flammable, toxic, and corrosive, and produces a dust that causes the serious respiratory condition, silicosis (Grossman 2006, p. 36, 37, 40). HDD producers, Seagate, say the facilities that undertake this work must be 100 times cleaner than a hospital. The wafers are vacuum photolithographed and ion etched to make the slider (Taetragool and Achalakul, 2011, p. 835). This type of dry etching process produces a waste gas, which is collected by a vacuum system requiring large amounts of energy ("Dry Etching…" n.d., para. 1) The slider can then read and write signals to and from the magnetic plating (Ieamsaard and Fuangpian, 2015, p. 99). For this to work, the disks must also be exceptionally clean. This is done using a varying range of acidic and alkaline substances, mechanical scrubbing, and numerous rinses in deionised water (Techradar, 2009, p. 2). The companies that enrol actor-networks to make wafers or sliders only achieve their goal of such cleanliness by organising the network structure in such a way that waste associations result.

An exceptionally clean environment is also required when constructing the front surface of the slider, which is an air-bearing surface (ABS). The ABS is a surface with a specifically designed pattern of grooves which allow pressurized gas to pass between the head and platter keeping them separate (Kunakornvong and Sooraska, 2015, p. 74). Very strict control of the environment is required in the construction of the ABS, as environmental changes can impact the performance of the whole disk drive (ibid.). Any contamination may result in heads crashing "on the disk surface" (ibid.). The gimbal itself allows for the slider to pivot and move, connecting the head to the arm (ibid). It is comprised of two alloys in a circular shape, each with different thermal expansion properties (Rubstov, 2016, para. 36). Exactly which alloys are used vary, making it difficult to ascertain the waste in their construction. The slider is attached to the gimbal by glue, and cured with UV rays in order to ensure the alignment

is correct (Kunakornvong and Sooraska, 2015, p. 75). The electrical paths are connected with a solder bond, and cured to rigidity with an infrared bond (ibid.). Defects and failures are very common during this process. In order to produce products with such precise specifications, again a waste actor-network is co-constructed. In this case, waste takes the form of defective product unable to be used.

'Just in Time' production

How the HGA production process (and the production of the HDD more broadly) works is informed ideologically by a concept known as the 'just-in-time' (JIT) method. This concept was introduced by Toyota to prevent the cost of unsold cars showing on inventory. It aims to keep production lean and streamlined, free from activities, people, or objects that do not add value (Prado-Lu 2017, p. 416). JIT production is embodied by a set of knowledge technologies, such as inventory and accounting practices, that enable long-distance control over a supply chain. JIT production favours smaller, higher frequency shipments by air and truck transportation over ship and rail (Bowen and Leinbach, 2006, p. 154). In this regard, a waste network in the form of emissions is created by the method. JIT ensures that companies are agile, and able to respond to effectively to market demands at all times (Prado-Lu 2017, p. 416). Essentially, such a model aims to eliminate waste, where waste is defined as 'non-productiveness' (Chua, 2015, para. 10). In tangible form, this waste includes, or arise from, factors such as holding unusable inventory, excess handling, and unreliable machines (Soltan and Mostafa, 2015, p. 478).

The JIT method (and similar ideologies of production) have correlated with new challenges for labour. The rise of the nightshift has contributed to increasing incidence of chronic sleep debt, associated with "weight gain obesity, metabolic syndrome/type 2 diabetes, and cardiovascular disease" (Prado-Lu, 2017, 419). Emerging evidence links shift work with neurological conditions like Alzheimer's and stroke, and in female workers particularly, breast cancers (ibid.). Workers report that new production practices in line with newer production ideologies intensify their experiences at work. In the Philippines, manufacturing activity like the HGA generally takes place within special economic zones. In these zones, low paid, monotonous assembly work is often carried out by women while higher paid, specialised, and technical jobs are carried out by men (McKay, 2006, pp. 227-228). In 2013, 64 percent of workers in the zones were women (Asian Development Bank, 2013, p. xiii). Within zones where electronics are the largest industry, this number can be up to 75 percent (World Bank, 2011, p. 195). In comparison with men, women are seen as having flexible schedules, being

attuned to repetitive tasks, as having "small and nimble fingers" to work with small parts, and as docile and less likely to organise (Prado-Lu, 2007, p. 94). A 2007 study of women working within the garment and semiconductor industries in the export zones of the Philippines exemplifies their experiences. More than half of the women reported exposure to excessive heat in their work (58.7%), and just under half reported working with noxious odours (43.1%) (Prado-Lu, 2007, p. 96). The most common workplace injuries experienced within the past year were eye infections due to dust (44.8%), and wounds from a sharp object (43.7%) (Prado-Lu, 2007, p. 97). 17.3% of workers reported being caught in the machines (Prado-Lu, 2007, p. 96).

The Philippines is characterized by low union participation across all genders (World Bank, 2011, p. 197). In contrast to the Chinese employers explored in the last chapter, there is a trend toward not providing housing for workers. Interviewees in a case study done by the World Bank in the zones reported this as being because such housing may cause labour activism to flourish (2011, p. 201). Most workers either live in the provinces around the zones, or in slums typified by a lack of access to clean water, power, and medical care (ibid). Until recently, the practice of using contract labour, where workers are employed on temporary contracts rather than hired full time, was widespread in the Philippines. Toshiba publicly declared their intention to end the practice in August 2017 (Mederilla, 2017, para. 1). Thus, many of the workers that worked on my particular HDD would have experienced the instability of work conditions where future employment is never secured, and worked without holiday, parental, or sick pay. The set of associations that typify contract labour have been organised as such so as to give employers the flexibility to meet demand by scaling up and down.

For smaller parts suppliers, the ability to both adapt to the whims of larger companies like Toshiba or Apple, and to compete to hold their custom in the first instance is dependent on flexibility and low prices. These smaller actors have tightly defined roles that often remain unchanged when larger actors like Toshiba declare they want their supply chain to be free of human rights abuse. For the assembly workers themselves, the whims of large corporations make their roles more restrictive, and they experience worsened workplace conditions as described here. They have less control over the lives they build. As actor-networks like Toshiba build networks to increase their power over suppliers (and thus, their profit), the workers within their supply chains are forced into association with conditions that harm them. Building a network necessarily involves building a network of waste.

Franco Berardi argues that neoliberal culture has 'injected' into the brain of western subject a "constant stimulus toward competition", while digital technologies have enabled

more "informatics stimuli" to enter the individual brain than ever before (2010, p. 36). For Berardi, this is because cognitive production is essential for modern formulations of capital. Similarly, Jonathan Crary argues that that the preponderance of digital technologies constitutes a multitude of new ways in which the Western individual brain becomes subject to control (2013, p. 60). For these authors, essentially human cognitive capacities are degraded by digital technologies in order to meet the needs of capital. The workers that make these digital devices belong to a different order of capital, which relies less on their minds and more on their bodies. On the one hand, these arguments presciently surmise the way that the strategies of power used by network builders differ in different conditions, and the argument further suggests that the expression of associations between different actor-networks is always unpredictable. One the other hand, such an argument is insufficient to express the experience of those that assembled my HDD. Parikka extends Berardi's argument, noting that capitalism promotes associations that constitute exhaustion, whether of mental capacity, environmental resources, or as is often noted as being the case of the HDD assemblers, bodily exhaustion (Parikka, 2015, p. 92).

The notion of exhaustion is a useful description of what arises between associations that I have been describing throughout as waste networks. At the same time, how we describe this exhaustion matters greatly. As Lucas, Kang, and Li conclude in their review of literature in a study examining dignity amongst the migrant workers in Foxconn, for Asian workers of many ethnicities self-worth derives from what others think of them (2012, p. 94). The experience of physical and mental exhaustion arises in networked interactions between workers, materials, and machines in such factories but also in the shared social interaction between the workers and the researchers that take them as subject. As noted in chapter one, there is a risk when describing the expressions of waste networks that despite intent, highlighting associations that have been made invisible ends up re-inscribing or reinforcing harmful network configurations. Bodily exhaustion can be experienced as a lack of autonomy over the body, which potentially leads to the creation of a false dichotomy between dignified academic and undignified, exploited worker. Rather than the researcher assembling a network of 'fact' rendering waste networks 'knowable', visibility may instead legitimise such associations. Resultantly, constraints on individuals already forced to act in particularly restrictive roles dues to youth, gender, ethnicity, or rural identities are amplified.

Neodymium

Assembling a network of actors responsible for providing the raw materials for the HDD is in some ways a similar endeavour to that of building a network of raw material

providers for the aluminium casing. It differs in that the HDD is comprised of very small amounts of a vast array of metals and components, and processed using many different elements and resources. Manufacturers increasingly try to use less expensive materials, and the materials and processes involved in HDD production ("Hard Drive Tear Down…" 2013, 4:40). All of the elements and resources used in the construction of a HDD change frequently. The market value of particular materials is a big driver of such changes, but reducing social and environmental impacts does factor to a lesser degree. This network is not necessarily driven by Apple or Toshiba. Instead, the component manufacturers of each part source their required raw materials separately. In the sense that they are comprised of relatively few actor-networks they can be considered micro networks. In comparison, the resource extraction sector (and the economy it is a part of) are macro-networks. Macro-networks are large actor-networks that have enrolled many different actor-networks of all different sizes, and kept them together. In this section, I focus on neodymium.

Neodymium is considered a rare earth element (REE). These elements are considered rare as they are found dispersed amongst other elements in a low concentration, and are not as scarce as the name suggests (Taffel, 2016, p. 125). Neodymium is a critical modern material used in defence, clean energy, and consumer products (Van Gosen et al, 2014, p. 1). Its prevalent use is in magnets. Magnets that include neodymium are incredibly strong. They are often used where strength is required but space and weight are limited, like in the spindle of the HDD (Van Gosen et al, 2014, p. 2). Their strength means they also used in large motors, such as in wind turbines and electric vehicles (Goonan, 2011, p.9). Neodymium then, as with the other REE not highlighted here, is an essential material for a circular economy. More broadly, since they are essential for technologies relating to surveillance, medicine, communication, and militarism their supply is a significantly charged geopolitical issue (Klinger, 2018, p. 1). Currently, the supply of REEs, including neodymium, is dominated by China, via a small number of mining and processing companies (Golev, 2014, p. 53). This has been the case since the 1990s, when REE production moved into the country due to lower labour costs and less environmental regulation in comparison to past producers such as the US (Abraham, 2015, p. 32).

Bayan Obo is the largest Chinese site of REE deposits (Taffel, 2016, p. 127). Extraction of REE is difficult, owing to their distribution and the fact they occur together and need to be separated. Processing them is an energy consumptive, chemical heavy process (Villard et al, 2015, p. 103). REEs are mined as an ore and physically separated into groups of different elements. The concentrated minerals are then treated in a chemical solution and removed

through hydro-metallurgic techniques like solvent extraction and ion exchange (Golev, 2014, p. 53). The waste products generated in this process are radioactive, such as the element thorium. Like with red mud, they have complex storage elements. There is evidence that the food supply and water in and around Bayan Obo have been contaminated by these tailings (Huang et al, 2016, p. 532). The impact on human and environmental health led mining company Baotou Steel to relocate farmers from surrounding areas in 2009 (Kaiman, 2014, para. 7). The workers that work in highly dusty areas within the mine have a much greater risk of lung cancer than the general Chinese population (Chen, Cheng, and Rong, 2005, p. 451). As with the mining of bauxite, the production of the aluminium case, and the HGA process, the associations that actor-networks such as these surrounding communities are forced into by mining and technology companies organising networks to suit them result in wasteful network expressions.

Despite these challenges, the recovery rate of neodymium is low (Peeters et al, 2018, p. 97). It is thought that between eight and 16 percent of all neodymium is used in HDDs (ibid.). Whilst there is significant potential for neodymium to be urban-mined from landfills or collected WEEE, such a technique is underutilized. The costs associated with the practice are high, and recovery of WEEE is poor generally. Similarly, it is possible to extract REEs from the tailings of other minerals, or through co-extraction, yet this method is scarcely employed (Golav, 2014, p. 53). Given the high concentration of neodymium contained in HDDs, there is at least some potential for Apple to become a significant industry presence. At present, Apple's recovery efforts are centred on iPhones, and take a disaggregated approach where materials are separated and recycled, as opposed to refurbishing or reusing the entire component (Taffel, 2016, p. 125). As was argued in the previous chapter, recycling in this manner does not so much circumvent waste as it does displace it, creating new waste associations. Mapping the neodymium actor-network reveals associations between the 'smart' and purportedly 'clean' energy and technologies of the circular economy and the mining practices of the older extractive economy. A site of potential inconsistency is highlighted in the narrative of progression that often accompanies circular economy thinking (Taffel, 2016, p. 125).

Realising Apple's desire to see an eventual end of their reliance on mined resources means building an alternate network of suppliers, materials, technologies, and knowledge. In practice, this means they will no longer occupy the role of resource consumer. Apple is an actor-network itself that acts as a network builder. When it comes to the use of resources, it has also taken up a role defined by other network builders belonging to the macro-network of the industry that controls extracted resources. These actors are able to manipulate the conditions

in which Apple act in this role to suit them; they are more powerful. For instance, they are able to set lower prices by externalizing the environmental cost of their practices. This means the actor/s in the Apple network responsible for purchasing and sourcing decisions (already constrained by the Apple network's drive for profit) choose to purchase their resources as opposed to investing in more extensive research into the recovery of secondary metals.

In turn, the resource extraction industry is a network built by powerful actors, and each actor-network (despite their vast size) acts in a role constrained by conditions manipulated by other actors. These actors are not solely human, involving economies, legal frameworks, commodity trading algorithms, and lobby groups *inter alia*. These actor-networks were built to serve particular needs of other actor-networks. This is a simplified description of complex and nuanced relations, and it is not intended to minimize the immense power and scope of Apple and other players to manipulate the conditions of other actors. The topography of these relationships is not flat. Power is distributed unevenly amongst these relations. Nor is it the case that the Apple network cannot act to remove themselves from this role. Nonetheless, it is important to consider power relations in this rather flattened way.

The task of this thesis is to elucidate the network of waste that Apple have built specific to my notebook. Mapping the Apple actor-network within a larger context makes visible the conditions under which it exists, to understand Apple as a network that has both enrolled many other networks, and been enrolled in many networks. Seeing all of these networks in one space potentially provides vital clues as to where the Apple actor-network is at its weakest, where intervention designed to address their waste footprint is best directed. As argued in the previous chapter, none of the associations that give rise to waste are sewn up. An actor-network with few associations is not contained in that position indefinitely. At the same time, the process of rearranging associations to prevent waste is fraught. As noted in this chapter, in the interaction between researcher and researched arises a shared experience, that can reinscribe waste networks.

Two important insights can be gleaned from the waste networks presented here. Firstly, waste relations do explicitly involve humans. This fact foregrounds one of the most pervasive critiques of Apple's zero-waste and the circular economy more broadly, its failure to address the social dimension of waste (Murray, Skene, and Haynes, 2015, p. 375). In many of the examples described over this chapter and its precedent, associations of wasting impact both human and non-human. Waste cannot be adequately understood without recourse to both of these elements. Relatedly, my second point is that as the researcher enters into association with the network being studied, they introduce new associations. Whether it is through reinscribing

wasteful relations, or through the 'rebound effect' where more efficient production stimulates demand, the very act of rearranging waste networks will introduce potentially unforeseen consequences. In the next chapter, I reintroduce the reason for this: any network is always hybrid, and the cause of any action is always spread across this mix of human and nonhuman actor-networks. The understanding of humans as separate from these networks, yet possessing a sole capacity to determine them, forecloses any effective action to prevent the worst of waste relations.

Concluding thoughts

This chapter shows that the actor-network/s that comprise the HDD, the HDD industry, and the broader ICT industry are not constant through time. Apple is a comparatively large actor-network as a micro-electronics provider, that has enormous power in shaping the conditions under which comparatively smaller actor-networks within its supply chain act. As the case of the HGA process shows, within the Apple actor-network, suppliers build their own supply chains. These suppliers, as has been demonstrated with Toshiba, bring their own ways of organizing the actor-network. Control is maintained over such supply chains through sets of knowledge technologies, like JIT production. Such practices, as I have shown, configure networks so that associations within them express wasting which impacts human and environmental health. I have argued that to challenge such relations it is necessary to broaden the analytical view to map the Apple actor-network as existing as a small actor-network within a much larger network. For the purpose of this discussion as it relates to the HDD, I have discussed the resource extraction industry through the case study of neodymium. These actor-networks are not static, and geological and geopolitical reality changes as actor-networks associate, networks form and disband.

Across the previous two chapters it has become evident that waste networks are built primarily to serve the needs of capital. More to the point, waste actor-networks are built by actors such as the mining industry and Apple that 'speak for' capital through their actions in search for profit. The individual consumer experience with waste is structured by these networks, as design decisions influence how (and how long for) the products they purchase can be used. Yet this does not equate to these consumers being passive. In the next chapter, I explore my experience of being in the consumer role. In doing so, repair emerges as a potential site for organising these associations in a way that disrupts some waste networks. Finally, this chapter has foregrounded the need to proceed with caution when attempting to build alternate waste networks, or circumvent waste by way of making it visible. I have demonstrated here

that there is the risk of relations of wasting arising in interactions between the researcher/activist and those within Apple's waste network. This is particularly salient when the researcher is positioned differently due to geographic location and identities. This being given, in the next chapter, I advance cautiously to circumvent waste by re-centring my focus to the role of care within networks. Care, I argue, borrowing from Haraway, is akin to staying with our troubles, recognising that we are always intimately connected to waste.

Chapter seven

Taking care of actor-networks: Batteries, users, and responsibility

In this chapter, the focus largely moves from material processes to decisions and relationships that are less obviously, but nonetheless are, material. To explore the relationship between care and waste, this chapter uses auto-ethnographic vignettes where I take my experience deciding what to do about my notebooks poor battery life as a starting point to foreground the user in the search for waste. The 'throwaway society' thesis posits any meaningful relationship between consumers and objects has been worn down by obsolescence and consumerism, creating a cycle of purchase and careless discard. This thesis informs texts both popular (e.g. Goldenberg, 2010; James, 2017) and academic (e.g. Bauman, 2002; Packard, 1961; Trentmann, 2016). As Cubitt notes, overconsumption is closely interrelated with overproduction. Critique of overproduction, however, shifts the focus from individual behaviour to collective, political action (Cubitt, 2016, p.7). Cubitt's comment foregrounds an argument highlighted by the waste associations outlined in the previous chapter: individual consumers do not make waste. In fact, as I demonstrate here in this chapter, the relationship between the consumer and object is complex. I argue that an understanding of waste as arising solely from consumer decisions is inadequate. To elucidate the complexities of the consumer-object relationship, I use auto-ethnography. Attempting to understand why we hold onto things, and repair, discard, or sell others is made difficult by the fact that doing so, in many instances, is an everyday decision. As the objects in our homes proliferate, the frequency with which we make these decisions increases. Repetition has the effect of leading us to no longer pay conscious attention to the decisions we are making, which makes verbalising them in interviews difficult (Uotinen, 2010, p. 166). Using my own experiences of such decision making enables me to work around these issues to map an actor-network of the consumer-object relationship. Significant actors, chiefly obsolescence and the lithium-ion battery, are introduced. I show how networks decay, and how human intention hastens or prevents this decay. I then consider what it means to care for an object, concluding with thoughts about who has responsibility within waste networks. Ultimately, this chapter argues that circumventing waste is not possible while imagining ourselves as separate from it.

Making decisions because of or despite obsolescence

Vignette one:

My daughter is at a holiday program in town as opposed to her school close to the university, so I plan to work at the central library. After getting set up, I realise I have forgot my charger. I know without it I have no hope of working until morning coffee. Sure enough, within half an hour the battery is dead and I need to return home.

My subjective experience of the notebook posits it as an object that I control in order to meet my needs. My subjective experience as 'user' and the notebook's status as 'object' are in actuality components of a material and discursive actor-network in which actors are constantly interacting and changing (Rubio, 2016, p. 60). My experience of the actor-network as an object is borne from a particular configuration of this actor-network (Rubio, 2016, p. 61-2). In other words, the notebook is recognisable to me as a notebook, because particular material and discursive realities are present. Since the whole actor-network is constantly shifting, for the notebook to remain recognisable labour, resources, and power (both in the electrical and political sense) must be continuously invested in it (Jackson and Kang, 2014, p. 230). Without this investment, the actor-network will evolve and potentially become unrecognisable. When the things experienced as objects like this do not act as expected, it provokes uncertainty in the user. The material and discursive realities that support the object are temporarily disturbed (ibid.).

This moment where the consumer has to choose to invest is a significant. In this moment, the "relations of value and order that are sometimes made invisible under the smooth functioning of complex sociotechnical system" can be seen more clearly by both user and theorist (Jackson and Kang, 2014, p. 231). In this moment, the power that the user has to determine the conditions of the actor-network known as the notebook is increased. They are faced with a decision significant in setting the conditions within which many of the actors in the network will be forced to act. Historically, this decision regarding what happens to a consumer good that no longer occupies its former role of object has been seen disproportionately as being the task of the consumer (Bishop, 2014, para. 8). They have been tasked with deciding whether or not to repair the object, and if so, how. If they choose not to repair, there is a choice about what to do with the object. The choices made here impact upon the fate of the actor-network, and the way the actors may decay and/or enter into other networks over time. Either path may result in the actor-network becoming reclassified as a 'waste' object.

As decisions are made about objects, the subjective experience is one of intention, of deciding on and implementing a particular course of action. Intention, like any other effect, is produced from the interactions between human and non-humans in an actor-network. As I have

noted, the decision has traditionally been conceptualised as a consumer decision. This decision, in actuality, is arrived at based on the interactions between actor-networks. Proximity of recycling facilities, the ease and cost of access to municipal landfills, and exposure to consumer education about end-of-life electronics are important actors. Holding a particularly powerful position in the intention actor-network is the phenomenon of obsolescence. Planned obsolescence is a "catch-all phrase" that incorporates all of the strategies used to "artificially limit the durability of a manufactured good in order to stimulate repetitive consumption" (Slade, 2009, p.16). Particularly relevant here are two types of planned obsolescence, perceived and functional. Perceived obsolescence refers to the strategies employed, such as changing the appearance, design, or functionality of a product, to make an object seem obsolete to the consumer (Pope 2017, p. 48; Spinney et al, 2012, p. 348). Functional obsolescence occurs when a technology cannot perform its intended task, either because of software or features that are introduced which are incompatible with older models, or due to an irreplaceable part no longer functioning. In a study of 1075 German consumers functional obsolescence was found to be the most common reason notebooks were discarded (Hennies and Stamminger, 2016, p. 79).

Obsolescence, as an actor, pre-exists the network created between the object and the user. It has a key role determining whether or not the user continues using a particular device. Thus, obsolescence interacts with a broader discursive regime of value. Such regimes are significant in informing which actor-networks human effort is invested in, but never entirely drive their fate. Materials act and interact outside of their place here. Nonetheless, regimes of value are inscribed upon material realities through obsolescence. Apple currently faces lawsuits related to their use of planned obsolescence in the United States, France, and Italy. In December 2017, Apple admitted they slow older iPhone models down without user consent through software updates. The justification given for such a move is that lithium batteries cause problems as they age, potentially leading to unexpected shutdowns and resultant damage to the very 'delicate' circuits inside (Greenfield, 2017, para. 4). Similarly, Apple are currently involved in legal action to block the introduction of 'right to repair' laws in the US which would mandate making repair guides and parts available to the public (Koebler, 2017a, para. 4).

Other significant influences on the decision to discard include size of the object, and the cost and hassle of repair. Whereas my decision to repair is unquestioned, and informed by my path of study, more than half of the respondents (65.5% on average) in a study on end of life decisions about ICTs had not had a broken device repaired (Bovea et al, 2018, p. 596). For the notebook specifically, the cost of repair being equal to a new machine was the main reason

given for this (Bovea et al, 2018, p. 597). These findings were replicated by a US study (Scott and Weaver, 2015, p. 18). The inconvenience of and uncertainties about repair also factored in the decision-making process (ibid). The decision to repair or not to repair ICT devices is often also influenced by their physical size – the smaller the size, the more likely an object is to end up in the trash (Bovea et al 2018, p. 590). They are simply easier to put in the bin. This is significant as personal computing devices are progressively smaller. Sabbaghi and Behdad note that only 6.8% of mobile phones, an example of smaller ICT equipment, are refurbished, remanufactured, or reused in the US (2018, p. 102). Considering that 'big brand' technology providers like Apple tend to promote recycling over reuse, it is likely that as personal computing devices get smaller, in the absence of a concerted effort to encourage repair, comparatively wasteful practices such as landfill and recycling, will continue to be the predominant consumer decision. This is exacerbated by design decisions made by Apple and other producers. Coinciding with smaller devices has been a shift toward gluing components together, which makes home repair much harder than in older models where parts are screwed together.

When the decision not to repair (and more broadly, not to continue 'using') ICTs is made, in many cases they are stored. In Hennies and Stamminger's study, for example, setting the device aside was the prevailing thing to do with discarded notebooks (41%), although smaller but significant amounts passed the notebook on (33%), and recycled or put it in the garbage (23%) (2016, p. 79). Bovea et al found that 73.91% of respondents had stored an ICT device (2018, p. 594). Most frequently, the rationale for this was given as 'emotional attachment', and 'a potential source of spare parts'. Similarly, in a 2009 study of 2136 US households it was found that there is on average 4.1 small and 2.4 large e-waste items per household in storage (Saphores et al, 2009, p. 3323, 3330). Another actor potentially impacting the decision of what to do with unused ICTs is the notion that old devices, even when 'wiped clean,' contain potentially sensitive information that can be used by scammers if sold. This notion has been perpetuated by the popular media (e.g. Khan, 2009; Quinton, 2015).

More abstractly, the decision to hold on to things that are no longer useful as objects is explained by Gregson, Metcalfe, and Crewe, who argue that the consumer goods we have in our lives "entwine with, constitute, and materialise particular identities" (2007, p. 685). Notebooks have provided a place to outsource memories, signal a particular status, were gifts, first big purchases, expensive, or purchased on credit. Removing ourselves from such "entanglements" by recycling or landfilling a particular item is not a process entered into easily (Gregson, Metcalfe, and Crewe, 2007, p. 685). Hetherington (2004, p. 169) argues that the

process of getting rid of an object is a two-stage process. The first stage is a 'holding' stage in which the discursive actors, particularly value, involved with the good are exhausted, or translated into another form to maintain an order recognisable for the user (Hetherington 2004, p. 169). Given the prevalence of storing devices outlined above, the 'holding' pattern is likely very common. It is only when such issues are resolved that the item is discarded, recycled, or re-gifted (ibid.). This is an anxiety-laden process. Similarly, this is true for objects beyond ICTs, as Evans has shown in relation to throwing out food (2012, p. 52). Whilst the user/consumer undergoes this experience with a general feeling of mastery, how they can act is curtailed by other, comparatively powerful actors (as exemplified in the discussion of obsolescence above). Implicit awareness of this likely contributes to this feeling of anxiety.

Along with the conditions imposed on the consumer-user by technology providers are the costs of processing, recycling, and disposing of digital detritus (Lepawsky 2012, p. 1202). These costs are economic, social, and environmental and range greatly based on 'place' in the network. For the affluent Western consumer, these costs are generally economic, such as the costs to municipalities of collecting, recycling, and landfilling e-waste paid for through municipal taxation. For less affluent Western consumers, the cost is greater and takes more insidious forms such as health issues working in a 'safe' recycling centre (see Stowell and Warren, 2018). Often these costs, in the form of environmental degradation, health issues, and a need for infrastructural spending, are passed on to other actor-networks of citizens. Not generally considered users or consumers, these citizens are located on the edges of Western spheres of privilege (whether due to Euclidean space, economic reasons, connection to the digital network or another factor). Costs arise for these consumers during both the production stages and disposal stages. These costs, whether economic, environmental, or social, represent an externalisation of the true cost of an Apple product. Such externalisation enables the producers of digital devices to make more profit.

To some degree, Extended Producer Responsibility (EPR) laws, in which legal institutions utilise their power in order to enlist companies like Apple into an explicit, defined role in the aftermath of the decision to discard, represent a restriction on the power of Apple and their ilk. Such laws differ from voluntary product stewardship measures, such as Apple's New Zealand take back programme detailed in the previous chapter. Mandatory product stewardship or EPR dictates requirements for how companies address disposal costs. This may be in the form of a fee to cover municipal collection, or a requirement to recycle a specified amount of product (whether their own or their industries). A potentially powerful actor, the laws rearrange the ICT-user-producer-government actor-network so that the producer bears more of the cost.

As Bishop points out, EPR laws are not a panacea (2012, para. 9). As the previous chapters show, producers have a poor record of acting in ways that ensure the safety of those within their networks. EPR laws may empower the Western tax payer, but it is less clear how that translates into other actor-networks. Even when treated responsibly, networks labelled as waste continue to act, often in unexpected ways. I return to the notion of responsibility later in the chapter, but for now I wish to highlight that the notion that industrial and consumer waste can be considered (and thus legislated) separately "reinforces the false assumption that consumers in Western Capitalist societies make garbage when in fact they neither make trash materially nor do they have much choice in what materials they buy and thus turn in to surplus stuff" (Gille, 2010, p. 1050). Apple's social and environmental practices are not substantially different from those of any other technology provider. Technological devices such as the notebook are often a required item, and consumers do not have substantial options available to avoid being implicated in waste networks. Further, that disposal costs are spread unequally amongst the global population suggests the idea that waste can be neatly divided into 'consumer' and 'producer' spheres is fallacious.

Decaying networks

Vignette two:
The plan is to change the battery myself, taking photos and writing about the experience. At the same time, I can give the back of the computer a much needed clean. For the past year or so it has got so hot that if I use the notebook as a laptop it burns my legs leaving a little rash. I've learnt it is likely dust that causes this. The cheapest price I can find it for online is $80.99, with another $19.99 for shipping. What if I get it, but it isn't right, doesn't work. Worse, what if something goes wrong when I switch the battery? Intellectually, I know that it is more than likely I'm able to change the battery myself. There is some part of me, however, that doubts my ability to do so. It's just past winter, and we've had big power bills. Work for my partner slows down over Christmas. If something did happen, we couldn't absorb the cost of a new computer, or extensive repairs. We have enough debt as it is. I do nothing.

Human actors build networks by arranging associations between other actors to elicit particular responses, although they can never completely determine how the network expresses itself. In a network, actors act and interact with those around them. It takes continuous investment on the part of the network builders to ensure a particular network configuration endures. Even

with continuous investment, as actor-networks within the human built network act and interact, form new associations and break with others, they change. The task for the human entity building the network is to ensure that the network continues to express itself in the desired manner. In this chapter, there are two human-led networks at play. Firstly, there is an actor-network built by me as I have purchased and used the notebook and accessories, connecting it to other human and non-human actor-networks. As discussed in chapter four, the act of purchasing is akin to me enrolling in an actor-network built by Apple. Secondly, Apple have built an actor-network. What goes on in 'my' actor-network is controlled to a large degree by Apple, who determine many of the other actors I associate with, and how many of the actor-networks function. This control is not total. Some of the associations I enter into will exceed my role. Insofar as I continue to use Apple services, this does not disrupt Apple's desired network expression. Similarly, as the components of the actor-network enter into associations, it only matters to me, the network-builder, if they break with the network expression I desire. As the battery of my notebook holds an increasingly diminishing electrical charge, the way that the network expresses itself is changing. These interactions destabilise the entire actor-network I have built.

This destabilising battery is otherwise known as lithium-ion polymer battery. Invented in the 1970s, it was not until 1991 that it was commercially used and distributed by Sony (Wu et al, 2015, p.3). The lithium-ion battery contains an anode, cathode, and electrode. The anode is made of porous graphite that holds lithium ions. The cathode is usually comprised of a mix of cobalt, nickel, manganese, or iron, and the electrode is generally a lithium salt. The notebook is powered by a chemical reaction occurring inside the battery as lithium ions travel from the anode to the cathode through the electrode (Gibbs, 2016, para. 5-8). The battery 'dies' when the lithium ions have gathered on the cathode, and is 'reset' to generate power again when it is charged (ibid.). Factors such as overheating, low temperatures, over charging, and allowing deep discharges *inter alia* all impact how long a battery will last for (Zubi et al, 2018, p. 296). It is relatively common that the lithium-ion battery destabilises the user-notebook network: when ICT equipment is repaired, battery changes are the most common procedure (Bovea et al, 2018, p. 597).

The lithium-ion battery in particular was selected for inclusion in the notebook by Apple as they recharge quicker, stay charged longer, are longer lasting, and provide a greater power to weight ratio than previous iterations of electrochemical batteries (Apple, 2018b, *Why Lithium-ion?*). Human values about what is desirable in a portable personal computer direct the way the notebook-network is built, and thus shape its material expression. At the same

time, the material affordances of the lithium-ion battery interact with other actors around them to produce effects in human affairs. The length of time away from an electrical outlet that lithium-ion batteries afford has seen a proliferation in computing devices designed to be mobile (Eisler, 2016, para. 2). This capacity to store energy, particularly in interaction with the fact that lithium-ion batteries are considered less toxic than chemical batteries, has seen them increasingly enrolled in 'green technology' networks. They play a key role, for instance, in the electric vehicle. Lithium's material properties have interacted with ideas, practices, and research of carbon neutral, zero-waste, and circular economy agendas to produce a vision for a particular type of sustainable, 'green' society (Zubi et al, 2018, p. 292).

Whilst the notion of a sustainable society may be heralded as a new mode of organisation, the technologies this society relies upon depend on 'older' modes of economic, technological, and productive organisation. The presence of these older modes greatly complicates the idea of 'green' technology. This is strikingly exemplified by the conditions under which lithium is mined. Most lithium is currently produced around the borders of Chile, Bolivia, and Argentina where it is found in brines (solutions containing dissolved mineral salts) (Flexer et al, 2018, p. 1190). It is also mined in lesser quantities from hard rock found predominantly in Australia (McLellan, 2017, para. 12). The brining method involves pumping brines from under the surface of large salt lakes into large ponds where excess water evaporates (McLellan, 2017, para. 15). Following evaporation, the brines are treated with sodium carbonate to produce lithium carbonate, which then undergoes electrolysis to produce lithium (Royal Society of Chemistry, 2017a, n.p.). This process generates a corrosive salt water by-product, which Cubitt notes has been allowed to "flow" into areas surrounding processing areas, where it kills "everything it meets" (2016, p. 68). The water pollution impacts biodiversity in the area, and poses a threat to human health (Wanger, 2011, p. 202). Further, it requires vast amounts of water to be pumped into very dry areas (McLellan, 2017, para. 16). The Indigenous farmers worry that this will exasperate water shortages already so bad that water is being trucked into communities in the area (Frankel and Whoriskey, 2016, para. 10). The annual compensation communities receive for extensive surface and water rights has been found to be as low as between 0.0036 and 0.024 percent of the sales the lithium mining companies generate (Frankel and Whoriskey, 2016, para. 5). Such a situation occurs due to underpaid public officials in the area accepting bribes, a situation, Cubitt argues, that is "all too familiar in resource-rich developing nations" (2016, p. 69).

The lithium mining actor-network described here reemphasises the earlier point that consumers do not make waste. Waste networks are built by actor-networks considerably more

powerful than the actor-networks we conceptualize as individual 'consumers'. Consumers, both collectively and individually, have roles within waste networks. When acting in regard to ICT equipment that has broken, or is unwanted, the conditions in which they are acting have been set by actors outside of what they experience as having dominion over. The individual decisions consumers make are significant in answering where there is waste associated with the notebook, but it bears stating that the waste does not originate with them, nor is it a phenomenon that can be confined to them. The media object is a significant part of people's lives. As it enters into a network with a particular or consumers, the actors affect each other in ways that can never be fully controlled by the original network builder. ICT equipment's status as object relies on both symbolic and material realities – it needs to both work materially, and retain symbolic value. Value is not generated equally amongst actors, but it is a collective effect. Yet, material and symbolic attributes are not always in temporal step. As I have noted, maintaining an actor-network as an object in the face of this takes continual work. ICT network builders can inscribe and direct these processes, but the individual consumer and the object can never be controlled entirely, their relationship entirely prescribed. Exploring why people chose to repair in conditions where replacement is easier potentially foregrounds the conditions necessary for building an alternate network, one which challenges relationships which result in harmful associations, like those that arise when lithium is mined.

Care by way of repair

Vignette three

My first call to a repairer located on the edge of my suburb is answered. We chat, and he says if it is a new battery, he'll have to order it in. He'll need the model number, so I'll send it through or give him a call and drop the machine in. I send him an email, and leave a voice message, but don't hear back. A couple of days later I try another repairer, even more conveniently located a two-minute walk from home. I make a point to be clearer, explaining my battery drains very fast, and that the machine over heats. He asks some questions, explaining that it may not be the battery that is the problem at all. Perhaps the fan isn't working, or dust is clogging it. Giving it a warrant of fitness will cost around $70, and he won't do anything that will cost more than that without checking in. We agree I'll pop in after lunch.

As media objects, and the networks that connect them to content, become more prevalent their users increasingly engage in the labour of caring for them. Care is an everyday activity, which I follow Tronto in defining as

> …everything we do to maintain and repair 'our world' so we can live in it as well as possible. That world includes our bodies, ourselves, and our environment, all that we seek to intervene in a complex life sustaining web (1993, p. 103).

Care, in other words, is an act that sustains particular relations. It involves the strengthening of relations that are beneficial to an actor-network, and the severing of relations that are not. Maintaining networks to enable a continuation of the best possible conditions for actors is not, contra to anthropocentric notions of caring, just a human endeavour. The non-human too acts to preserve and adapt conditions in order to flourish (Bellacasa, 2010, p. 164). For Jackson, repair itself comprises repeated acts of caring such as maintaining, preserving, and extending, in a process that transforms order, meaning, and value along with the material (2014, p. 222).

In order to differentiate from the concept of immaterial labour[5], I employ the term 'digital housekeeping' to describe this labour of caring for the media object. Digital housekeeping refers to the work involved in building and maintaining a networked presence. It is concerned with the labour of programming, linking, troubleshooting (including recruiting outside help), managing, 'backing up', and maintaining connections between devices and the internet, each other, television, and audio-visual systems (Grinter et al, 2005; Kennedy et al. 2015). Kennedy et al found that the distribution of who carries out these tasks (including seeking external expertise) is based on interest and experience along with gender – digital housekeeping is more likely to be carried out by men (2015, p. 419). Given that definitions of digital housekeeping do not tend to expressly include work that is often performed by women in other domains such as managing warranties, ensuring accounts are paid, cleaning (including internal and external dusting), or managing children's access to the objects and networks, more research is likely needed to fully understand the phenomenon. I have drawn attention to this however, because confidence in regard to one's skills and competence in both general 'do it yourself' repair and in programming new consumer electronics has been associated with males more so than women (Blackwell et al, 2009, p. 335; Potot, 2013, p. 67). Making repair of media objects more accessible and desirable means recognising that different users have different needs, and will be better serviced participating through different repair networks.

[5] A phenomenon which is largely (but not exclusively) concerned with the care of the immaterial, maintaining social networks and online communities, updating web pages to reflect current events, tending to game worlds and so on.

These repair networks are simultaneously constrained by geographic space, connected by ICT, and characterised by flows of people, information, and materials. Indeed, as New Zealand does not play a significant role in the design or manufacture of ICTs, we are always implicated within global networks. How the devices are to be used is inscribed elsewhere, and resultantly "forces and trends emanating from abroad may drive local uses and repair of technology" (Ahmed, Jackson, and Rifat, 2015, p. 4). Knowledge, too, is globally networked (ibid). There are repair networks all over the world, with different roles for the actors (Ahmed, Jackson, and Rifat, 2015, p. 4). Western media users have a choice about which of these networks to enter into. In my experience, a lack of confidence ultimately determined the type of network I chose. As pointed out above, my gendered experiences likely contributed to this. Regardless of gender, the lack of confidence, and a feeling of a lack of knowledge, is relatively common. Chen and Wong, for instance, in a study of Taiwanese computer users, found that 70 percent do not know what to do when their computer does not work as expected (2018, p. 35).

That the media object is often black-boxed, its workings obscured, likely contributes to this. Discourses relating to 'magic' were often employed to describe the computer in earlier years, as Stahl demonstrated in a content analysis of *Time* magazines articles from 1979 (1995. p. 253). For Kittler, user-friendly software and interfaces that are simple to use and increasingly intuitive act to obscure the material conditions (that is, the hardware) that make them possible (2013, p. 211). When you are unable to understand how something works, fixing it becomes impossible. Counteracting this does not necessarily mean equipping the entire population with a working knowledge of computer hardware, nor does it mean that 'drop off' repair services are necessarily the best option. Indeed, it could be argued that such services further the notion that the media object is too technologically complex for a large number of users to be able to manage simple fixes such as battery and screen changes themselves. On one hand, largely unsuccessful experiments in modular phone technology represent large tech companies such as Google recognising, at least to some, degree that many consumers do like to tinker with their media hardware. On the other hand, practices favoured by Apple such as gluing batteries in suggest that tech companies would prefer customers not update and repair to their liking. Should I still be in the warranty period, any repairs carried out myself or any non-Apple authorised repairers would have voided my warranty (Apple, n.d., *Legal*). More research would be beneficial to elicit which solutions meet consumer needs best.

Toward taking responsibility for electronic forms of waste

Vignette four:

After a few days, my computer is ready to be picked up. I walk down, and chat as I pay. He explains that my actual battery has held up quite well. What looked to be carpet fibres had wrapped around the fan, inhibiting its function. The resultant overheating was the cause of the battery's poor life. As I had suspected, the computer was very dusty, and he had given it a good clean. I'm embarrassed, both because I really should have done this myself, and because I let something of mine get so dirty. I privately wonder if the carpet fibre was actually bits of my hair, which is long and has a tendency to get everywhere.

Care, or not caring, is a necessary decision because the networks that comprise our world are always in flux, simultaneously in genesis and decay. These processes of change cause particular harms, and mark the end of networks. At the same time, new networks are generated. These new networks are often networks we think of as waste. Classifying these new networks as waste can be thought of as a process of translation, a material expression "profoundly implicated in the maintenance of a stable social order" (Hetherington 2004, 160). In this process, an entire network comes to be represented by a single actor. Should my notebook cease to be an object, it enters into a new network, involving the local council facility where I might recycle it, the workers that separate the computer, and down-stream recyclers *inter alia.* These actors all come to be represented and managed by a classification as a particular type of waste: 'e-waste'. If the notebook is not to become waste, to continue to be recognisable as a notebook, then it must be maintained (Latour, 1987, 137). Since actors are always acting and interacting, there is no inertia – the notebook requires an 'active customer' to perform software updates, remove dirt and dust, wipe the screen and so on (ibid). With these actions to sustain particular actor-networks, others (like the fibres) are disrupted, given new conditions under which to act.

With care, then, comes a certain amount of responsibility. To some degree, I am responsible for the care of the notebook. We are all connected in vast, complex networks. These networks, as has been built upon in previous chapters, involve associations of wasting. As discussed in chapter four, powerful actor-networks like Apple work to obscure such waste networks. As Goodin explains, responsibility can be understood as being owed to "all those who are vulnerable to our actions and choices" (1985, p. xi). Care, and responsibility, can be exercised by both humans and non-humans alike. This responsibility is likely one actor that catalyses the anxiety people feel about wasting. It arises from "our particular and situated context," the experience of living "our individual lives" (Shotwell, 2016, p. 203). Purity,

innocence, or complete removal from these networks is never possible; as we are involved in networks where other humans and the environment are organised into wasteful associations, we always harm someone, somehow (ibid.). The task ahead is, as Haraway so aptly describes, not to completely reconcile or restore networks but to build deep commitment to the "more modest possibility of partial recuperation and getting on together" (2016, p. 10). For Haraway, doing so is akin to "staying with the trouble" (ibid.).

Whilst it seems obvious, it is worth stating that one person (or one actor-network) cannot resolve their responsibility alone. Waste is created and maintained collectively, and thus redesigning actor-networks in a way that mitigates these wasteful associations is a collective endeavour. Each actor is bounded, limited in how they can act, but being aware of place in these networks and finding new ways to act within them can provide the conditions necessary for "a collective moral response" (Shotwell, 2016, p.135). MacBride argues that the challenge for the individual experience of subjectivity is not constantly striving for the 'right' action, nor is it to do 'more' to exercise my responsibility, but instead to do so justly, consciously (2012, p. 126). Indeed, there can be no 'right' action, because actor-networks are by nature heterogeneous. Even within Apple's limited conception of waste, they recognise that different approaches are required for different types of waste (2017, p. 17). They even recognise that some types of waste can be 'good'. Ultimately, however, the zero-waste strategy presumes that all waste networks are material, and separate from the cultural realm that will eventually govern them. Not only does this obscure human presence in waste networks, but it prevents an effective response to waste. An effective response to waste addresses the fact that as humans, our survival is as much tied with the fates of pervasive actors like red mud as it is with the waterways and farms it has poisoned.

It is important to note that recognising our shared existence with waste does not translate solely into publicising the issue. More people knowing where e-waste ends up, and how many people suffer to make the notebook will not alone lead to change in the face of the constraints on consumer behaviour, like obsolescence, that have been discussed. To a large degree, due to the way that some relations, in particular many of the incidences of wasting thus far, are made invisible so as to avoid delegitimising powerful actor-networks, citizen consumers are unaware of the negative implications of their ICT equipment. This was indeed my experience, detailed in the opening reflections. Keeping waste networks invisible, or making only particular waste networks visible, is a way in which power is maintained. At the same time, as material actors and ideas like the ones described here, discarded devices, poverty, toxic water, impaired human health, and plastic pollution, flourish, act unexpectedly, and are

represented as waste networks, they often become what Latour refers to as 'monsters' (2011, pp. 24-5). Their ability to influence human affairs is recognised, and feared, and as Victor Frankenstein did with his monster, condemned. The problem is either construed as 'wicked' and too big, or entirely eradicable through simplistic solutions addressing only part of the network.

Thus, it is not solely the case, as Latour points out, that citizen consumers are simply unaware, or are entirely oblivious to the conditions in which they make decisions (Latour, 2005a, p. 29). The anxiety that typifies the process of disposal suggests that people are aware that few of the available disposal options are 'good.' When citizen consumers are made aware of waste networks associated with electronic goods like the notebook, these networks are often represented as monsters. As Andersson has demonstrated, these representations that depict workers like those at Agbogbloshie often take the form of the 'toxically sublime', constructing a problem that is both urgently dire and relatively removed from modern life (2015, p. 274). Yet in the absence of real and meaningful choice for how to deal with ICT equipment that is no longer being used (or usable), making people aware of the problem is little more than a futile exercise in promoting apathy and guilt. ICT equipment is a requisite for modern life, and the decision to discard is never a solely individual choice. Thus, individual awareness that begets individual action on its own will never amount up to enough to generate meaningful change (Shotwell, 2016, p. 203).

The zero-waste promise directly addresses the unease these 'monster' waste networks provoke. However, it is clear that even if adopted with the best of intention, Apple's zero-waste promise is problematic. When vast, diverse waste networks are translated and represented by one powerful actor-network like Apple, the conditions in which the entire network is made possible are often obscured. Zero-waste translates the waste networks built by the company into a single actor that can be eliminated, in the process rendering many waste actor-networks invisible. The adoption of the zero-waste/circular movement by Apple (and indeed, its nascent power as an organising discourse in wider capitalist actor-networks) as a strategy suggests that the threat of actors- climate, 'waste' materials, communities- destabilising the network is growing. Minimising these actors, or at the very least minimising their discursive actor-networks power, within the network is necessary for Apple to retain power.

Concluding thoughts

This chapter has taken my experience in having my notebook repaired as the starting point to explore the decisions made by human actors to prevent, or hasten, processes of wasting.

As a result of working on this thesis and being a media studies student in general, my experience will never be entirely generalizable. However, caring for a technological device, including its maintenance and disposal, is an everyday part of life for many Western consumers. From the personal and specific, more general relations emerge, enabling insight into the way that networks surrounding ICTs are maintained through time. Independent of human intention, networks change. Objects collect dust, break, rot, and rust. Itself a network of human and non-human actors, human intention and motivation nonetheless play a significant role in determining how networks form or disband, and waste or grow. At the same time, individual intention must always be understood as constituted by an actor-network comprising powerful extra-somatic actors, as I have argued here in relation to obsolescence.

Ultimately, the argument in this chapter has argued that understanding ourselves as separate from waste networks forecloses any possibility of ameliorating the worst of their effects. Dealing with waste requires the understanding that we are always connected to waste networks, and thus our fate is associated with theirs. This is true for companies like Apple, who rely on waste networks to survive, but it is also a useful way of thinking about what to do as an ICT-owning individual. My fate, that is, is bound with the notebook and all the waste associations that relate to it. Rather than a dictum to be spread, or a blueprint for all, this is simply an observation, a starting point. Repair, in this chapter, enabled me to exercise my responsibility to the waste network I became a part of when I associated with the notebook. What is particularly telling, is that repair is a site where, judging by Apple's legal and other actions to prevent it, their power is at its weakest. Thus, in the conclusion I suggest that repair may be a site from which to begin the task of building a common world with the waste networks obscured by 'zero-waste.' Ultimately, I argue that the networks that have been describe here cast doubt on the possibility of a truly circular economy.

Conclusion

Repair the network, not the economy

This thesis has elucidated the types and forms of waste associated with my Apple notebook. Understanding waste in the ANT tradition as an agentic, relational phenomenon makes evident that humans are implicated with waste. Environmental waste and human wasting, that is, cannot be considered separately. This understanding of waste contrasts with purely symbolic definitions (waste is something unwanted), and official policy descriptions (waste electrical equipment are the devices that end up in landfill). The definition of waste I mobilise is largely at odds with the way that Apple conceptualise waste. I argue, however, that even within Apple's comparably limited definition of waste, the evidence presented here overwhelmingly suggests that their conception of zero-waste is not a viable way to significantly reduce the negative impacts the extraction, production, consumption, and disposal processes associated with the notebook. Insofar as the case studies here are applicable to the ICT and wider industries, this is true for the circular economy at large.

Apple's zero-waste strategy is primarily a marketing exercise that creates a false ontology of the separateness of waste. The centrality of waste to capital, demonstrated by the aluminium casing and HDD waste networks mapped here, means that attempts to mitigate the harms of waste often fail. The concept of exhaustion conceptualises the researcher-subject relation in this light. Through auto-ethnographic study and the concept of care, repair emerges as a tentative way in which redesigning networks may become possible. In this section, I draw together these insights. Ultimately, I conclude this thesis by noting the circular economy model is inherently flawed, and that political action must explicitly be geared toward adapting the model so that it is better placed to redress the social and environmental consequence of the traditional extractive economy.

Discourse analysis of Apple's 2017 *ERR* demonstrates in two key ways that for Apple, zero-waste is a way in which to increase their power. Firstly, it is a strategy to enrol more environmentally-conscious consumers into their network. Secondly, the reports paradoxical treatment of waste serves to increase Apple's power. The report describes (and thus inscribes) a reality where large corporations manage their waste themselves, in conjunction with suppliers, consumers, and local municipalities. To this end it constructs finding solutions to waste as a necessarily collaborative endeavour. National or international bodies with the power to set regulations on how Apple can act, however, are for the most part obscured in the representation offered by Apple. Making these actors invisible increases Apple's power by

legitimising their solution to waste by constructing it as the only solution. Similarly, the *ERR* offers a limited conception of waste that obscures the human aspect of waste networks. Such a move increases Apple's power by making invisible realities which may hamper their social licence to operate. On the other hand, the report sets out a future in which Apple's innovation will lead to the development of technologies that will eradicate waste. This innovation, it is important to note, is occurring without government regulation. It is thus implied that regulation may hamper such a reality. The *ERR* suggests that Apple, if allowed to exercise their innovation, will fully take responsibility for their products after consumer use. Doing so has the added benefit for Apple of increasing consumption.

The ambivalent status of Apple's control over waste networks is highlighted by the case studies of the aluminium casing and HDD. The production of each of these components results in the creation of a vast waste network. Apple are to a large degree culpable for this network, as they organise their network by selecting companies to contract particular tasks. By setting particular prices for these tasks, they structure the conditions under which these companies act, resulting in associations that give rise to human and environmental waste. This power is maintained through the use of knowledge technologies, as was demonstrated by the set of policies Apple employ to be able to direct how their third-party recyclers act despite geographic separation. These directives are notable as they run contra to concerns about shredding expressed in the *ERR*. A similar technique, JIT production, is employed by other actor-networks to maintain control of the HGA process. Avoiding waste, which is largely conceptualised as inefficiency, is the rationale for the implementation of JIT. Although the result of the associations created in the shredding and JIT processes are different (energy loss and harm to human health respectively), waste networks are a commonality of each waste reduction tactic.

At the same time as Apple is responsible for this waste, much of the waste network associated with the notebook is outside of Apple's direct control. The raw materials that Apple rely on come from large mining companies which have enrolled many more actor-networks than Apple. They thus have a great deal of power determining how Apple, a comparatively small consumer of raw material, can act. In much the same way that Apple design their goods to become obsolete to stimulate consumer demand, mining companies set prices that stimulate demand for virgin, as opposed to recycled, materials. In turn, the capitalist market sets the conditions in which mining companies act. An incredibly powerful actor-network comprised of economic policies, algorithms, traditions, discourses, ideologies, humans, and materials *inter alia*, capitalism as an organising principles sets the conditions under which mining

companies and Apples acts. As a guiding principle, it structures vast networks around the pursuit of profit. This is not an expression of intention per se, but the result of interactions between the aforementioned vast actor-network.

Similarly, waste actors like fluoride emissions and red mud do not act with intention. Yet they do arise from networks that have been structured, at least in part, by human intention. When these actor-networks come into association with others the results can be unpredictable. The power to structure networks, bringing particular actors together is never total, always emergent. The possibility remains that particular associations will destabilise the entire network. Beyond Apple's zero-waste rhetoric, actors like fluoride emissions and red mud highlight a problem with the circular economy more generally. Because power is never assured, complete control over material networks is impossible. Fluoride emissions and red mud are complex actor-networks that are difficult to predict. The harm they have already caused, whether in the form of forestry die back, global warming, or alkaline poisoning, is not static. These actors will continue entering into associations, and there is little evidence that the circular economy model is able to address this. Further, even if we disregard pollution already in existence, unpredictably means that zero-waste, circular economies are 'leaky.' One rogue actor, whether human or not, regardless of intention, that enters into an association with another may eventually end up continuously enrolling more materials and more people. Part of the problem with the circular economy, then, is the ontological framing of human intention as able to completely sublimate materials at will.

Further, attempting to understand phenomenon such as waste divorced from any social context prevents the ability to develop solutions that are robust enough to address complexity. Where harm to the environment has been described here it has invariably been accompanied by harm to humans. Waste that is 'human' in nature is present in the form of disruption to traditional ways of life and livelihoods, depletion of basic human rights, displacement, injury, and death. Exhaustion, the physical experience of being 'used up', too tired to function normally, arises in workers producing HDDs for ICT devices. Ironically, production approaches enabled by these same networked technologies, such as the JIT method, are responsible for structuring the actor-networks the workers are a part of in such a way that the exhaustion results. It is too simplistic, however, to attribute this exhaustion solely to JIT production. The experience of exhaustion also arises in the shared experience created as workers describe their workplace situation to researchers. This is significant, insofar as attempting to make particular waste relations visible can end up reinscribing those same relations in different ways, in this case through creating a false separation between researcher

(powerful, dignified) and research subject (powerless, exhausted). Consequentially, unequal power relations are legitimised. Most significantly for the circular economy, this demonstrates the way that researchers do not exist outside phenomenon, but are instead one actor in a network of associations that give rise to that effect. This erodes the ideas that scholars can be ontologically distinct from waste networks and that humans can be outside 'material' systems like circular economies.

The notion of exhaustion reminds us of the embodied consequences of waste network management not captured by the circular economy model. The circular economy relies heavily on networked digital technologies to store and process the large volumes of information necessary to tightly control material input and output. Yet, neither Apple's zero-waste model or the circular economy model have any way of conceptualising the human input and output that is required for such an economy in terms other than economic (as the financial cost of labour). At their core, zero-waste and the circular economy are just new methods of manufacturing and services to "benefit the biosphere," and thus are "virtually silent" on human issues (Murray, Skene, and Hayes, 2015, p. 376). Yet separating human and non-human waste into 'social' and 'environmental' problems forecloses any possibility of truly being able to address waste. At the very least, this is because a comprehensive understanding of the social context of those that work with waste is necessary to successfully enrol them in a network being designed to circumvent the worst waste effects, as demonstrated in regard to waste workers at Agbogbloshie and in Guiyu. At worst, when deployed by companies like Apple, the discourses of environmental sustainability can actively work to obscure incidences of human harm.

Beyond merely allowing for the creation of a map of waste, understanding waste as a hybrid human and non-human phenomenon foregrounds the question of how we move on as part of a collective identity that is more than human. To rework an argument made by Haraway, the problem is not so much waste itself. Networks are never permanent, and must always be maintained. Networks change, and things decay, rot, break, and die. What matters in this context, Haraway argues, is ongoing-ness (Haraway, 2016, p. 163). Insofar as waste networks are inevitable, the human role in organising them must foreground generational survival of networks that are always both human and not. Expressing care, tending to and maintaining networks vulnerable to us, is the way in which we as humans can express a responsibility to ensure the ongoing-ness of networks vulnerable to the choices we make. The particular responsibility actor-networks have is determined by their situation within the collective web of relations.

Using my own experience tending to my notebook, I cautiously suggest that repair is an easy and practical way in which individual consumers can both express their responsibility to the networks they become a part of when they purchase an electronic device and address the anxieties many people feel at the end of a devices life. Given the problems highlighted with accessing repair services, as well as the issues with cost, inconvenience, and accessibility, I do not wish to over-state this claim. More research is needed to understand the conditions under which consumers do select repair as an option. Nonetheless, in the process of repair, new actor-networks emerge that constitutes a recognition of consumer implication in vast waste networks. It is a step toward preserving ongoing-ness through rearranging waste associations to mitigate waste networks in the form of climate change and pollution. It draws upon a set of skills already possessed by many workers considered part of the 'informal' electronic waste economy. Of course, much of the ICT infrastructure, such as fibre-optic cables, data centres, and GPS satellites, is not repairable by, or even visible to, Western consumers. These infrastructural elements may be privately or nationally owned, and physically span or transfer information across national borders. This does not mean that the ICT consumer is completely absolved of responsibility for infrastructural elements per se. However, these infrastructures foreground consumers implication within a complex geopolitical situation.

Firstly, repair is a tenet of the circular economy. Yet, Apple's reticence to adopt repair within their zero-waste model speaks to potentially unresolvable tensions between capitalist organisations that function according to a logic of increasing profit and a truly sustainable model of production. Apple's model of takeback and recycling is a common way in which circular economy thinking manifests. Whilst this is undoubtedly a step up from single use and disposal, regardless of how efficient any such scheme is 'waste networks' of lost embodied energy still result. The circular economy is a capitalist economy and waste networks, following Cubitt, are in fact integral to capital. For a truly circular economy, waste networks like the ones described here need to shrink. Progressively less materials, less energy and less people need to be enrolled in the production process. Empirical research into the circular economy has demonstrated that its benefits only occur when demand is reduced, or at the very least stabilised (cf. Makov and Vivanco, 2018; Zink and Geyer, 2017). Thus, this directly contradicts capitalist economies organised around growth and profit. It is imperative then, that a truly circular economy cannot be shaped by multinational corporations (Narbehaus and von Mitschke-Collande, 2017, para. 8). Such corporations, because of their inherent profit-driven motivation, are poorly placed to design models that are robust enough to address all of the social and environmental externalities, the waste networks, that arise in the production of goods.

Further complicating the geopolitical situation, the consumer is implicated within is that the impact of waste relations associated with ICTs (and production more broadly) are distributed unevenly. The effects of climate change associated with emissions, displacement, and loss of biodiversity are all experienced differently in different actor-networks. The notebook provides a way through which consumers can understand this connection. Some actor-networks are put more at risk by the waste network's association with production. For example, the extraction of rare earth elements to make 'green' technologies forces people from their homes and lands, as in Baotou. Likewise, the production of lithium makes life increasingly difficult for indigenous South American farmers. These actor-networks are disproportionately put at risk by the circular economy. Understanding the connections between green technologies and waste networks will only go so far, particularly within a geopolitical context in which borders are rigidly enforced. In an historical moment where understanding ourselves as implicated within global networks is pivotal to combat widespread social and environmental harm, the discourse of the nation-state is re-emerging as a network organising structure (Latour and Riquier, 2017, para. 5). This compounds waste networks, and will make it harder for those already displaced.

Thus, designing a truly circular economy cannot be left to the nation-state. As Latour has argued, governments have few tools with which to conceptualise and design policy that incorporate environmental and social goals (Latour and Riquier, 2017, para. 12). The political task of researchers and citizens alike is not just to make visible the issues, but to explicitly stake a claim as to which networks have their ongoing-ness preserved (Haraway, 2016, p. 163; ibid.). There is no simple way in which this can be done. Zero-waste as offered by Apple is an appealing idea, but fails to address the complexity of the social and environmental impact of networked communication devices. Similarly, the circular economy has promise, as the case of repair suggests. Yet to be truly effective, the model must become robust enough to include humans within it. The technologies that the circular economy relies upon, such as ICTs, wind turbines, or electric vehicles, all contain elements that are associated with substantial harm to both humans and environments. These harms, to be clear, impede the ongoing-ness of particular actor-networks in order to preserve others. Political action is needed to ensure that citizens, academics, and advocacy groups are able to have a say in the process of determining which networks are preserved by the circular economy, and which waste networks are depleted. Currently these decisions are made disproportionately by powerful corporate entities. Only with the inclusion of all citizens into these decision-making processes will a start be made at

exercising effective, collective responsibility to the networks in which we as humans are situated.

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