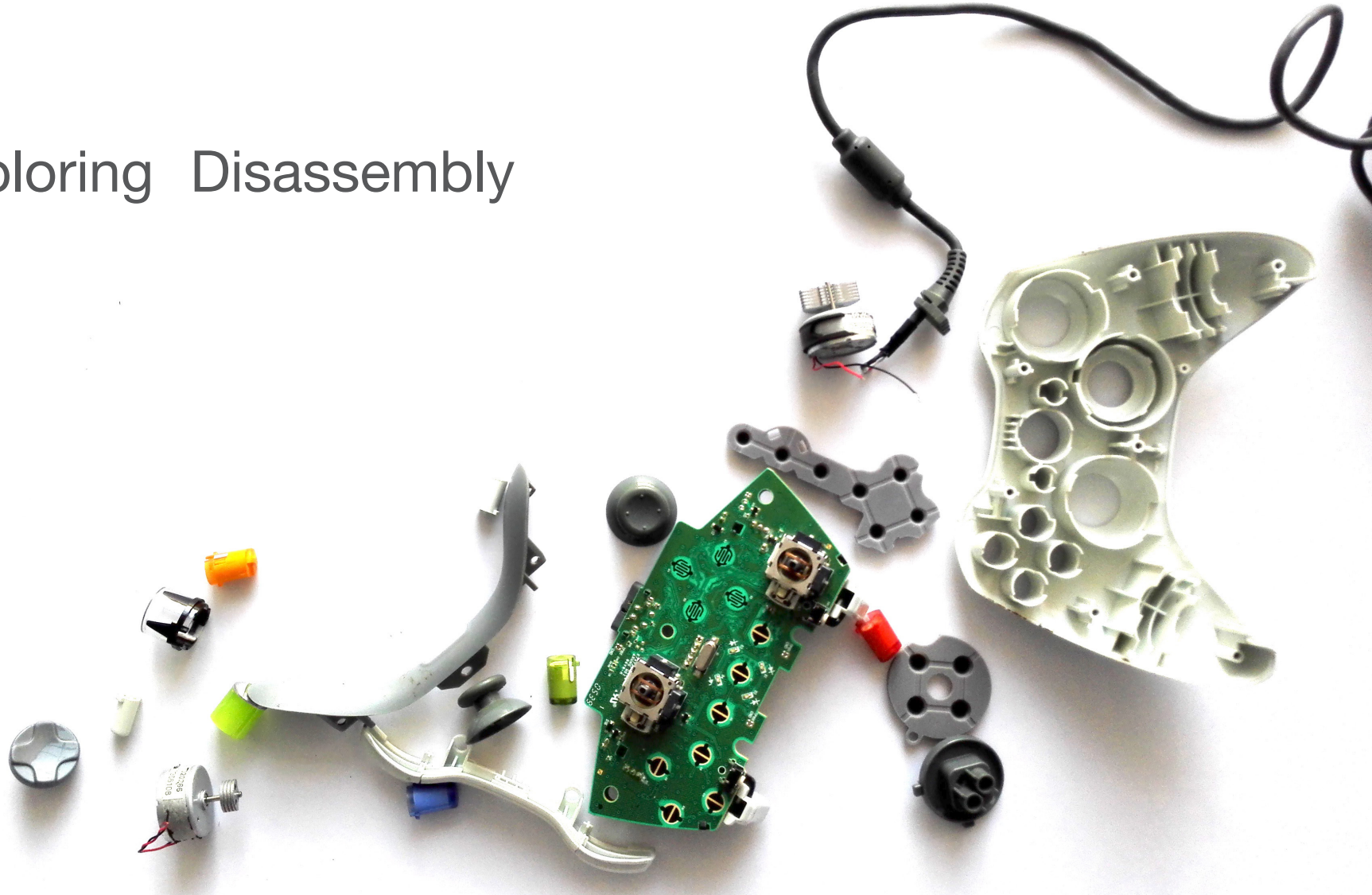
Affective Disassembly

A Study Exploring Disassembly and Emotion



David Jarvis
February 2020
MSc Sustainable Design
Aalborg University

Title Page

Type of thesis: Master Thesis
Project Title: Affective Disassembly

Programme: MSc Sustainable Design
Department: Department of Planning
Institution: Aalborg University, Copenhagen

Author: David Jarvis
Sttudent Number: 20172431

Supervisor: Jens Iuel-Stissing

Project Duration: September 2019 - February 2020
Submission Date 29th February 2020

AALBORG UNIVERSITET
STUDENTERRAPPORT

Abstract

This project seeks to speculate on a concept of transposing product disassembly and material separation from the first act of a post-ownership, industrialised, waste-handling practice to the last act of product ownership. It asks:

How could Design for Disassembly be conceptualised when considering disassembly as a consumer practice?

The project commences with desk research in the areas of circular economy and electronics waste. This along with a field study of disassembly practices at one of Europe's largest recycling plants, forms the contextual knowledge from which the research question is derived. Subsequently, two research workshops are held during which an individual is requested to disassemble products so the affectivity of the practices may be studied. This paper culminates in the proposition of a potential new approach to design for disassembly, Affective Disassembly, and suggests that the study of disassembly practices, and their human affectivity, may be aided by the consideration of 'matters of engagement and experience'

Contents

Introduction

This project seeks to speculate on a concept of transposing product disassembly and material separation from the first act of a post-ownership, industrialised, waste-handling practice to the last act of product ownership. It asks as a research question:

How could Design for Disassembly be conceptualised when considering disassembly as a consumer practice?

It seeks to use the study of practices as a starting point to establishing an empirical approach to understanding what factors might be pertinent to the progression of this concept.

Set in a time of emphasis within Europe of the necessity to explore novel methods in sustainable production and consumption (UN. org) - in a time of growing attention and encouragement of a shift toward circular flows of materials in the sphere of manufactured goods from various groups of society and societal institutions (refrefref) - in a time of increasing waste streams from electronic goods (WEF 2019, Baldé at al. 2017), this project is a contemplation of how the design of products may contribute toward wider diffusion and enrolment in circular economy strategies.

To this end, it takes two disparate design ethos's, Design for Disassembly and designing for pleasure and emotional attachment, both of which are pre-supposed to hold significant potential for contribution toward Circular Design (Moreno et al. 2016), and asks how such a combination might offer new insight for the field of Sustainable Design. Throughout, in the back of the author's mind, is the ponderment of 'what if the practice of disassembly is inscribed in a product's form not as a matter of necessity but as a matter of desire?'

The inquiry steers clear of assessing which circular economy strategy is most effective in terms of sustainability. Indeed, it also remains neutral on whether circularity of technical materials, in itself, delivers on environmental sustainability. Instead, it adheres to the view that disassembly is a fundamental first process step in the majority of circular economy strategies (Venegas et al. 2017) and seeks analyse disassembly only as a practice. Theories of Practice are used as a theoretical base, guiding the study.

The project commences with desk research in the areas of circular economy and electronics waste. This along with a field study of disassembly practices at one of Europe's largest recycling plants, forms the contextual knowledge from which the research question is derived. Subsequently, two research workshops are held during which an individual is requested to disassemble products so the affectivity of the practices may be studied. This paper culminates in the proposition of a potential new approach to design for disassembly, Affective Disassembly, and suggests that the study of disassembly practices, and their human affectivity, may be aided by the consideration of 'matters of engagement and experience'.

Theory

In this chapter, the underlying theoretical concepts of the study are presented

Theories of practice

The theoretical spine underpinning this work is that of Practice Theory. Throughout this project, theories of practice will be used not as a topic under investigation but more as a paradigm of analysis. In other words, the focus will not be on assessing the credibility of Practice Theories but instead to use it to help form the analytical approach. Though this project seeks to comment upon the design of artefacts, it is the practices undertaken with these artefacts that is primarily observed.

Theories of Practice differ from many behavioural sociological scholarly traditions in that they promote the practice itself, and not the human practitioner, as the unit of enquiry for understanding the social phenomena. The human practitioner's actions are deemed resultant of the emergence and suffusion of practices (Nicolini 2013).

Practice Theory was chosen due to my judgment that it is particularly apt when being applied to Sustainable Design. This is due to the systematic and socio-technical characteristics attributed to Design for Sustainability. Practice Theory's origins lay within sociology, at its foundations, it is the study of why humans conduct themselves in the ways that do (Shove et al. 2012, Reckwitz 2002). Design, in this sense, can be seen as only one pragmatic application of the empirical understandings of Theories of Practice. It should be noted that there is not one unified, singular 'Practice Theory'; given the vastness of this academic tradition's scope - that is, to address social and human phenomena, multi-contextual by nature - it is considered correct to refer to the topic in the plural form, as Theories of Practice (Nicolini 2013). Whilst this view is respected, throughout the course of this document, I will use the two forms interchangeably, solely for the purpose of simplicity.

There are three main motifs of Practice Theory that this document will refer to repeatedly. Other elements and vocabulary may be used from the Theories of Practice, and they will be introduced at their time of use, but the remainder of this chapter will be used to introduce the three staples.

Practice as an Entity and as a Performance

This concept, in essence, distinguishes between the existence of a practice and the form in which that exists. A distinction between as what and as how one's actions could be described (Watson 2012).

Take, for example, the washing of clothes. As an entity, this could be considered as taking dirty clothes and, via a process of actions, converting them to clean clothes. As a definition, this is relatively universal. Furthermore, logically, before clothes existed, the practice of washing clothes did not exist.

Washing clothes as a performance, however, is relatively not universal. There are many different forms in which this process of actions may take place. Some may use a washing machine, some may use a river, some may use liquid detergent, some may use powdered detergent.

Rather than forming a theoretical pilar of Practice Theory, this terminology is used as a descriptive tool. I find this concept one of the most essential for understanding Practice Theory as a whole, though I also find it the least rigid in terms of its definitions; in my interpretation - at least when applied to socio-technical systems - what is an entity in one perspective could be considered a performance from another. Less as an objective, absolute definition and more as a vocabulary for describing an action's level in a cascade subject to that of another's action. So, for example,

this project may differentiate between reusing and remanufacturing as two distinct performances of the practice of circular production/ consumption. However, circular and linear may be viewed as two distinct ways to perform industrial production/consumption.

The Recursive Relationship Between Actors and Structures

A practice, as an entity, as put forward by Reckwitz and Shove, is consistent of three elements. The emergence and sustainment of a practice is reliant upon the formation of links between these three elements. In Shove's description, these three elements and their definitions are as follows:

Materials – including things, technologies, tangible physical entities, and the stuff of which objects are made;

Competences – which encompasses skill, know-how and technique; and

Meanings – in which we include symbolic meanings, ideas and aspirations.
(Shove et al. 2012, p8)

Further to this, theories of practice stipulate that through these elements mediation between practitioners and social structures occurs (Watson 2012, Røpke 2009)

Design for Disassembly

The Springer 2nd Edition of Design for Environmental Sustainability: Life Cycle Design of Products, authored by Carlo Vezzoli, defines the discipline of Design for Disassembly as focusing on "how to design easily disassembled products; meaning that the parts and materials can be easily and economically separated" (Vezzoli 2018, p175). The remit of this project is to explore additional relevant factors that could attribute to disassembly, beyond those of ease and economy.

Indeed, the significant majority of the texts encountered when researching Design for Disassembly position the field in an engineering design context. Ease of disassembly - that is pertain to the speed and the cost of the activity is of particular importance in this sense (see Venegas et al. 2017)

A key work to this thesis, from a design for disassembly stand, is the work of Peeters et al. (2015, 2017). In tase two texts, the viability for elastomer based fasteners is tested. These are referred to in the discussion of this thesis.

Designing for Pleasure and Emotion

Three frameworks for analysis for understanding pleasurable and emotional experiences with products are consulted and deployed during this study:

Chapmans 'Six point experiential framework'. This is a framework describing aspects of consumers' relationships with their possessions. The framework is presented to designers to instigate exploration of the concepts. The elements and Chapman's definitions are:

Narrative: Users share a unique personal history with the product; this often relates to when, how, and from whom the object was acquired.
Detachment: Users feel no emotional connection to the product, have low expectations, and thus perceive it in a favorable way due to a lack of emotional demand or expec- tation. (This also suggests that attachment may actually be counterproductive, as it elevates the level of expectation within the user to a point that is often unattainable.)
Surface: The product is physically aging well and develop- ing a tangible character through time and use (and some- times misuse).
Attachment: Users feel a strong emotional connection to the product, due to the service it provides, the information it contains, and the meaning it conveys.
Fiction: Users are delighted or even enchanted by the product as they do not yet fully understood or know it, especially with a recently purchased product that is still being explored and discovered.
Consciousness: The product is perceived as autonomous and in possession of its own free will. It is quirky and often temperamental, and interaction is an acquired skill that can be fully acquired only with practice.

(p33 Chapman 2009)

Jordan presents definitions of four 'pleasures' to categorise how consumers derive pleasure from products:

Physio-pleasure
This is to do with the body and with pleasures derived from the sensory organs. They include pleasures connected with touch, taste and smell as well as feelings of sensual pleasure. In the context of products, physio-pleasure would cover, for example, tactile and olfactory properties.

Socio-pleasure
This is the enjoyment derived from relationships with others. This might mean relationships with friends and loved ones, with colleagues or with like-minded people. However, it might also include a person's relationship with society as a whole—issues such as status and image may play a role here.

Psycho-pleasure
Psycho-pleasure pertains to people's cognitive and emotional reactions. In the case of products, this might include issues relating to the cognitive demands of using the product and the emotional reactions engendered through experiencing the product.

Ideo-pleasure
Ideo-pleasure pertains to people's values. In the context of products it would relate to, for example, the aesthetics of a product and the values that a product embodies. For example, a product made from bio-degradable materials might be seen as embodying the value of environmental responsibility.

(p13, Jordan 2000)

Lastly, a set of 22 basic human emotions as taken from a PhD study by Ortiz Nicolas (2014). These were of particular interest as they were used in a study which sought to understand the underlying emotions users felt toward some of their most favoured possessions.

Method

In this chapter I present an overview of the work carried out during the course of this project, and describe the methods used therein. The project is research based and can be bisected into two phases: contextual research to arrive at the formulation of the research question; followed by two workshop sessions aimed at providing novel empirical content in response to the research question.
Theories of practice underpin the methodological scheme of this project and practices act as the primary focus of analysis throughout.

First Phase, Contextual Research

Desk Research

Desk research was conducted as an initial step in gathering contextual knowledge and data.
Acknowledging that this project would be addressing issues concerning sustainable production and consumption of manufactured goods with a focus on circular economy strategies and design, my literature search used two key taxonomical overviews as its origin. These were: Moreno, overview of circular design strategies; Ceschin, for an overview of designing for sustainability (Moreno et al. 2016; Ceschin/Gaziulusoy 2016).

Beyond the texts put forward by these taxonomies, other academic articles from published journals and books were sought on a range of topics pertaining to design, disassembly, sustainability, circular economy/material flow and engineering. In addition to academic texts, particular attention was afforded to reports commissioned by and/or directed at government bodies or makers of European environmental policy.

Semi Structured Interview

During the visit to Stena Nordic Recycling Centre, I conducted an interview with the communications officer. The interview was semi structured in its style. This allows for the interviewer to navigate the interview in the direction of their interest, yet with the objective of allowing space for the interviewee to express their opinions with little restriction (Guest et al. 2017).

The interview was used to gain an understanding of the processes and practices at the recycling plant. It was audio-recorded and writing materials were available so that we could sketch meanings as well as verbalising them.

Participant Observation

Participant observations were also used at the recycling plant. By visiting the site of the practices, as they are being performed, offers a greater degree of insight (Guest et al. 2017). The purpose of this was to see the plant's internal processes unfold. This included the manual processes - how the employees of the plant physically handle waste fractions - and the mechanised processes.

Second Phase, Workshops

Shifting the focus of participant observation from disassembly practices performed in an industrial setting to those in a domestic setting, I facilitated two ‘disassembly workshops’. These were with the intent of gaining insight to a consumer’s sensorial and emotional perception when performing disassembly.

Workshop 1 - Sam

As an initial, exploratory study into establishing how the realms of disassembly and affection may be linked , a subject was selected to observe while undertaking acts of disassembly. A workshop was set up using a methodology which Jordan refers to as ‘Think-Aloud Protocol’. During such a workshop, a participant is encouraged to verbalise their thoughts and experiences as they interact with a product. The investigator will loosely guide the activity in a semi structured manner and may prompt the participant occasionally to verbalise at specific points (Jordan 20009). In this case, I selected a subject, Sam, and presented him with three products for disassembly.

Selecting the participant

For this exercise I felt it important to select a participant with a preexisting positive bias toward disassembly. The hypothesis of this project is that by increasing the appeal of product disassembly to consumers, their desire to undertake disassembly should also increase. In this sense, it seemed advisable to investigate the contributing factors of an existing practitioner’s disposition toward disassembly before investigating whether these factors can be propagated to a wider population.

Fig 1

I first contacted Sam through the Repair Cafe Denmark organisation. Repair Cafes are volunteer organisations which hold workshops periodically to which members of the public bring goods in need of repair. Also in attendance are volunteers with a penchant for - and often accompanied by expert knowledge of - product repair. During the workshops, the volunteers attempt to restore the broken products, free of charge (Repair Cafe Denmark). Sam was an enthusiastic volunteer at Repair Cafe Østerbro and also previously worked for a company which would repair mobile phones. This combination of professional experience and personal interest in disassembly and repair was the reasoning for his selection for this exercise.

Staging the workshop

Sam, the participant, and I, the investigator, congregated around a table in view of a mounted camera which recorded the session in video format. Video was chosen so that not only the participant's verbal response was captured but also his actions and body language. The participant was presented with three products: a video games console controller, a soda machine and a coffee machine.

As an introduction to the exercise, the participant was instructed to:

> Verbalise his feelings during the teardown (the disassembly process). These should include emotions regarding pleasure and displeasure that particular actions instigate, and the physical sensations experienced during particular actions.
>
> To carry out the teardown to the extent of his own choosing. He was given some background knowledge of the project and that the general goal was material separation but not given a specific goal or required level of separation, instead to continue until he felt no longer inclined to do so.

Workshop 2 - Luis

Refinement of pilot study

The most apparent weakness in the approach of the pilot study was that it did not provide enough encouragement to the participant to express their emotional response to disassembly. To attempt to improve on this in the next iteration of the study, inspiration was be taken from a PhD research thesis. The focus of which is understanding pleasant experiences with products (Ortiz-Nicolas 2014).

The author of the PhD study used a set of emotions, both positive and negative, derived from studies in the field of psychology. These emotions were used as a starting point to establish a framework for assessing participants' relationship to owning what they perceived as 'great' products. Later, certain relevant emotions were studied in more depth. I use a similar set of emotions (with a few exclusions deemed not suitable) to see if a similar approach is feasible when attempting to study participants' relationships to acts of product disassembly. The emotions were printed on to cards to act as prompts, encouraging my participant to refer to them when describing their experiences.

The purpose of using Ortiz Nicolas' set of emotions in workshop 2 is for the participant to use this vocabulary, if appropriate, to refer to the emotional reaction specifically to the physical acts of disassembly. He is also encouraged to provide his own vocabulary in the case that the emotions on the cards are insufficient. This is to attempt to draw parallels between certain actions and certain emotional responses.

Further to this set of vocabulary, the participant is also provided with the terms used in Chapman's six-point experiential framework (Chapman 2009). This set of vocabulary is a proposal from Chapman to give product designers the nomenclature to explore the pathways of designing for emotional durability. The participant is given the six terms, again on cards, along with Chapman's own description of each term. These terms describe more complex facets of human-product emotional relationships, than those of the more elemental set from

Ortiz Nicolas, and are therefore used as prompts for describing the participant's attitude toward disassembly on a more general level.

The workshop with Luis was video recorded. This was later analysed to count occurrences when the participant expressed emotions or feelings - either those expressed on the prompt cards, or others which appeared to be of significance.

Below are images of (left) the set of emotion cards derived from Ortiz Nicolas (2014) and (right) Jonathan Chapman (2009).

Fig 2

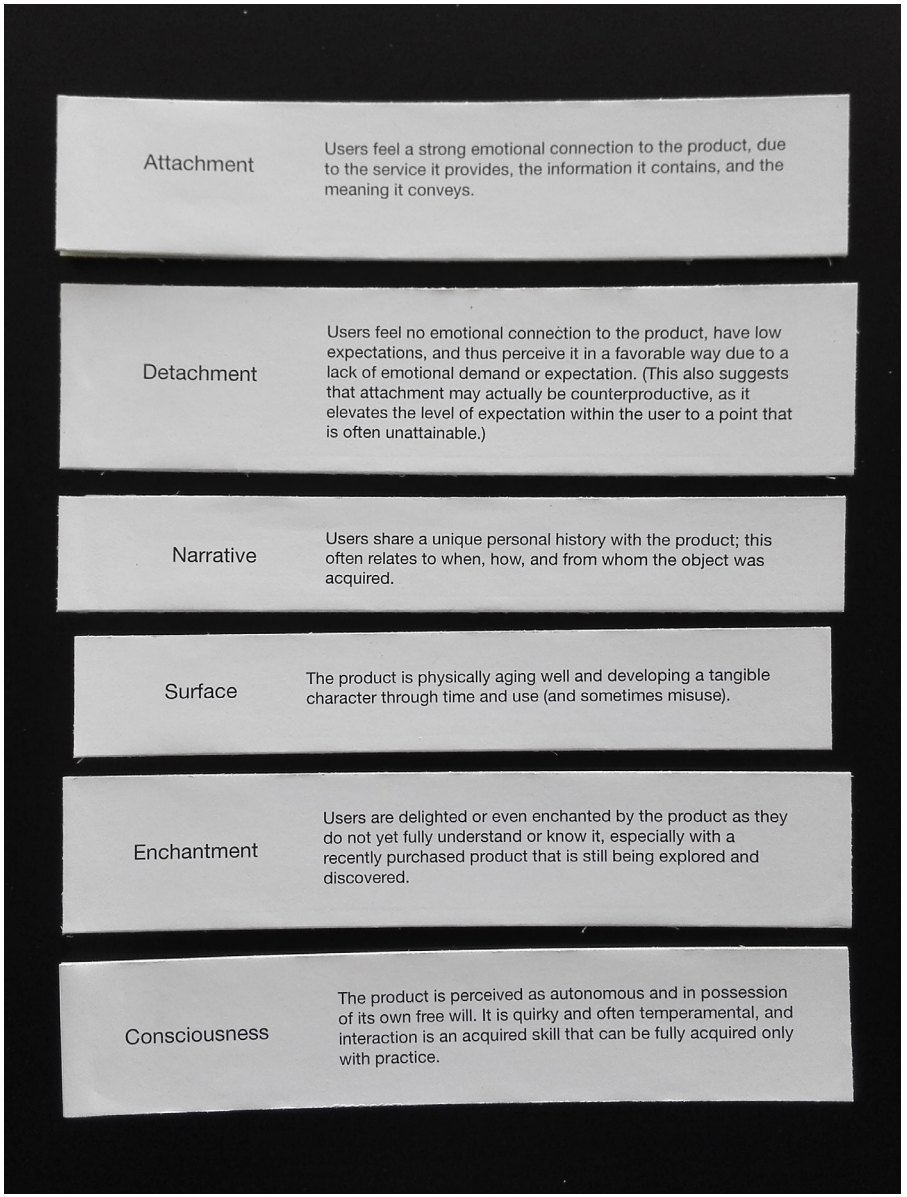


Fig 3

Findings

First Phase

Practices in industry and arrival at research question

Practices in Industry

To gain insight on the practices involved with recycling as they are currently performed in an industrial setting, I visited Europe's largest recycling centre, Stena Recycling A/S's Nordic Recycling Centre (SNRC) in Halmstad, Sweden. There, I met with the communications officer to discover and discuss the processes undertaken at the facility and how these processes fit into the wider complex of practices in their circular material supply chains. The visit consisted of a 1.5 hour interview and a visual inspection of most processes on the site. In this section I will present a few choice extracts from the interview and offer up analysis from the perspective of practice theorists.

Due to the commercial sensitivity of the content, I am unable to present the interview transcript in full, nor provide photographic imagery of the processes. All content presented as factual relating to SNRC's processes should be considered as being derived from the information presented to me during this visit unless referenced otherwise.

SNRC's Position in A Nexus of Practice

Practice theorists describe practices (as entities) as often consisting of sequentially connected and overlapping complexes of sub-practices. In some situations, artefacts can be described as objects that thread-through these sequences (Shove et al. 2012).

To establish SNRC's position and role within this nexus, the communications officer and I drew a diagram throughout the course of the interview. Below is the result. This is a representation of SNRC's position in the process of material circulation, with respect to its external connections. Loosely put, this is reflective of its business model. It purchases its inputs and sells its output, even within the wider Stena organisation. Their contribution to the value chain is through material separation and extraction.

The outputs, on the right of the diagram, are not all profitable; supply chains relating to the 'reuse' category are in their infancy but are reflective of the organisation's desire to contribute to circular economies. Consigning material to landfill incurs tax payments. Storage of unsold waste items such as refrigerators has an associated cost. Interestingly, due to evolving technologies or actor networks, wastage previously consigned to landfill/storage will occasionally be reintroduced to the extraction processes if the value in doing so is deemed greater than the cost of re-committing the leftovers to landfill.

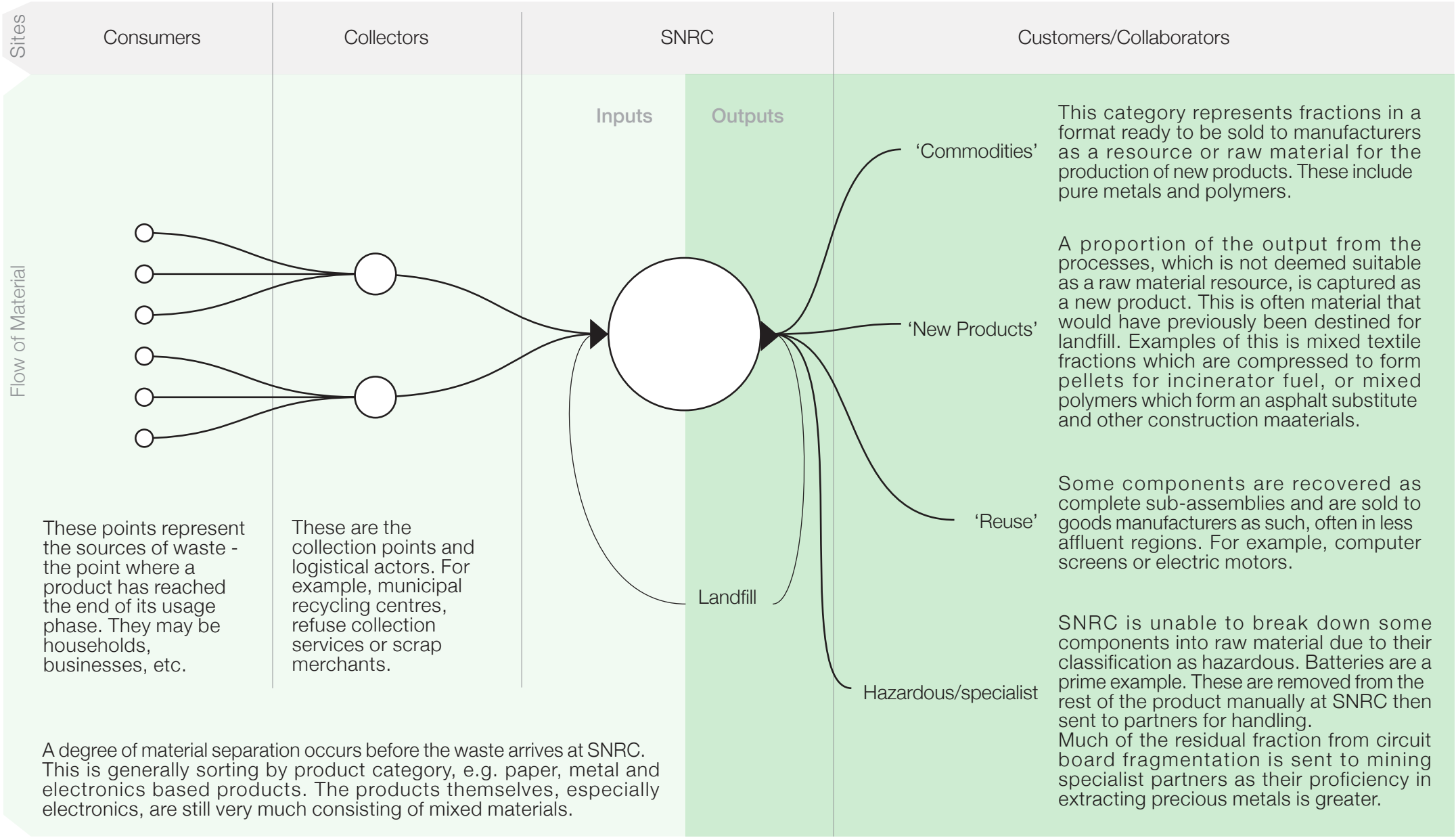

Sites
Consumers
Collectors
SNRC
Customers/Collaborators
Inputs
Outputs
Flow of Material
'Commodities'
'New Products'
'Reuse'
Landfill
Hazardous/specialist
These points represent the sources of waste - the point where a product has reached the end of its usage phase. They may be households, businesses, etc.
These are the collection points and logistical actors. For example, municipal recycling centres, refuse collection services or scrap merchants.
A degree of material separation occurs before the waste arrives at SNRC. This is generally sorting by product category, e.g. paper, metal and electronics based products. The products themselves, especially electronics, are still very much consisting of mixed materials.
This category represents fractions in a format ready to be sold to manufacturers as a resource or raw material for the production of new products. These include pure metals and polymers.
A proportion of the output from the processes, which is not deemed suitable as a raw material resource, is captured as a new product. This is often material that would have previously been destined for landfill. Examples of this is mixed textile fractions which are compressed to form pellets for incinerator fuel, or mixed polymers which form an asphalt substitute and other construction maaterials.
Some components are recovered as complete sub-assemblies and are sold to goods manufacturers as such, often in less affluent regions. For example, computer screens or electric motors.
SNRC is unable to break down some components into raw material due to their classification as hazardous. Batteries are a prime example. These are removed from the rest of the product manually at SNRC then sent to partners for handling.
Much of the residual fraction from circuit board fragmentation is sent to mining specialist partners as their proficiency in extracting precious metals is greater.

Fig 4

Fig 5

Fig 6

SNRC's Internal practices

SNRC handles waste from three main sources. These are: electronics waste, from a variety of origins; cars, once they have been shredded at Stena's fragmentation plant, situated on a neighbouring site; and some non-household plastics.

Illustrated in fig5 is the internal process for the electronics waste handled at the facility. This can be divided into two main sections. These are: 'first treatment' - this is the department where the waste is inputted, manually handled and the first stages of material separation take place; and automated processing - beyond first treatment, machinery continues the acts of material separation until it is in its outputted state.

The first treatment section is of relevance to this investigation due to its involvement and reliance upon human actors. The automated, mechanised processes, which generally consist of a series of shredders, trommels, floatation tanks of different densities and conveyors, will henceforth drop out of this study's focus as they are deemed to be the concern of the field of engineering studies.

The waste arrives at the facility in stillages. The waste is an entangled mixture of electronic products in various states of completeness. First treatment has two main objectives, for which Stena prefers the use of human handlers. The first is to untangle and sort the items. Items which may potentially be fed into their re-use market (see fig4) are extracted. The remaining waste, which is destined for the shredders, is sorted loosely based on product type due to their constituent materials. For example, screens may be grouped together for their proportionally high glass content, or speakers for their ferrous materials. The second function of first treatment is to start coarse material separation. Their prime intent is to manually remove hazardous materials such as batteries and other subassemblies which require specialist handling as opposed to shredding. They will also remove and sort cabling or other relative material-homogenous components. The semi-sorted, semi-separated material exits the first treatment building as piles ready to be collected by loader trucks and fed to the shredders.

Implications of disassembly on SNRC's practices

It was well established during the interview that material separation is crucial to the organisation and is fundamental to their commercial viability at present. The communications officer expressed that it was only feasible to spend a relatively short amount of time manually processing each item and, therefore, two closely related factors greatly impacted their processing abilities. These were: the complexity of materials assembled within each item; and the difficulty, expressed in terms of time, that it takes to separate these materials. In her own words:

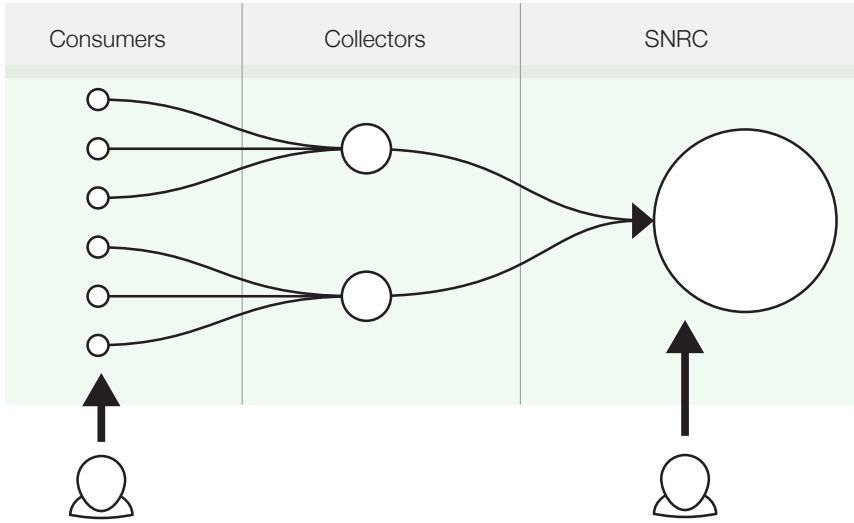
> ***"It would be great if a computer was made from just one material but that's not possible. But, yes, the easier the products (are to separate materials) the better it is for us."***

She gave some examples of how an inability to separate materials in a time-efficient manner leads to a reduction in the quantity of material that is able to be recovered, thus leading to reduced profitability and reduced contribution toward material-flow circularity.

> ***Communications Officer: You know the vacuum cleaners that are wireless? For the batteries in those, you have to take out the small vacuum motor, then have to punch out the battery or take out small screws, so we don't do that because it takes too much time. You'll see we have the band [conveyor belt] which goes pretty fast.***
>
> ***D: Okay, so there's a balance, at the moment at least, between disassembly steps and human tact time versus economic recovery.***
>
> ***CO: Yes. One of the most harmful things for us for first treatment are these tiny toys, like those from MacDonalds. They contain batteries, so are classified as hazardous waste, but they are designed so that you can't take out the batteries because kids are going to play with them. They are used for like three minutes and then they get thrown away. So when they come in here, we can't unscrew and take the batteries out, we can't crush them because there's so much plastic, so we just have to throw them away and pass them on [to specialist handlers]. They are the worst.***

Different approaches to altering and improving first treatment practices are being explored. The communications officer gave insight to how the organisation is working with a coalition of vacuum cleaner manufacturers to explore the use of robotics to aid in the process. This approach involves manufacturers influencing the socio-technical system through the industrial arrangement directly. The work of Peeters et al. takes a more human-centric approach but is still aimed at performing disassembly in an industrial context. Their work includes psychological considerations, such as the intuition and cognitive processes of the human operators, but still frames its arguments in terms of time and consequently cost savings (Peeters et al. 2015, 2017).

The avenue of my investigation is to consider how designing for disassembly might utilise other points of intervention when proposing alterations to the practices and socio-technical system supporting circular economy strategies, aside from those based only in the industrial context. From the study of SNRC's internal and external processes, it can be seen that there are two moments at which electronics waste is manually handled:



Here, as the last act in the hands of the consumer

and here, during the recycling centre's 'first treatment' process.

Fig 7

Subconclusion and Arrival at Research Question

From the findings presented thus far in this chapter, and from the theory chapter, it has been established that:

Disassembly of products is a fundamental first step in the performance of many circular economy strategies, including re-use, repair, remanufacturing, recycling and upgradability.

The complexity of the material content of waste products that arrives at an industrial recycling plant directly influences the plant's ability to recover material.

Consumer electronic products are particular problematic offenders of the previous point.

Design for Disassembly literature seems focussed on aiding in the separation of components and materials in an industrial context post-usage phase of a product's lifecycle.

Given the above and considering that practice theorists suggest:

> *"Practices (and therefore what people do) are partly constituted by the socio-technical systems of which they are a part; and those socio-technical systems are constituted and sustained by the continued performance of the practices which comprise them. Consequently, changes in socio-technical systems only happen if the practices which embed those systems in the routines and rhythms of life change; and if those practices change, then so will the socio-technical system."*
>
> (p2 Watson 2012)

This study chose to take the 'rhythms of life' of a consumer of electronic products as a starting point to enquire into how product design - and by association the state of the relative socio-technical system - could be approached in a novel way to support CE strategies.

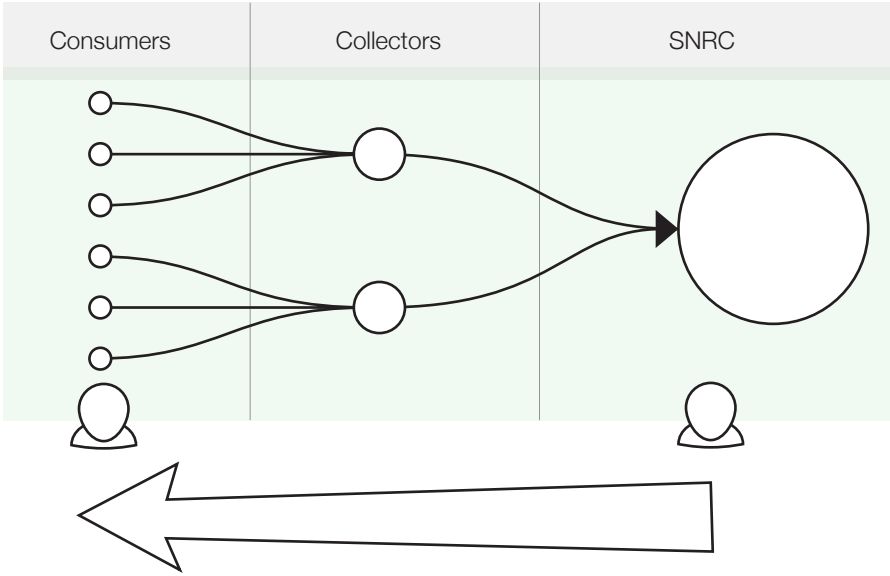


Fig 8

This study considers encouraging material product disassembly to begin upstream in the value change.

The notion that practices mediate a relationship of recursive influence between social structures and individual practitioners (Røpke 2009) acts as validation for choosing the practitioner, in this case the consumer, as the subject of investigation.

In this light, the project seeks to ask what could be added to the academic understanding of disassembly when considering it as a practice performed by consumers. It asks what factors are of importance to the performance of disassembly in a domestic context in addition to an industrial context. It asks what understandings are transferable from established academic traditions pertaining to human-product relationships and seeks to assess a hypothesis that Design for Disassembly, Design for Emotional Attachment and designing pleasurable products may hold useful synergies when combined for Design for Sustainability purposes. Hence the arrival at the research question:

How could Design for Disassembly be conceptualised when considering disassembly as a consumer practice?

Findings

Second Phase Research Workshops

Analysis of results from Workshop 1 - Sam

Sam doesn't naturally discuss his emotions or his personal reaction when performing disassembly actions, as was the hope with the study. Instead, he naturally tends to report his actions in a much more matter-of-fact style, stating why he is performing certain actions as opposed to how he is experiencing these actions. There is a sense that the teardown is a task with a clear goal as opposed to an explorative exercise.

It was difficult to quantify the outcomes of the workshop. Below are some points which appeared most prevalent:

> Emotions were mostly referred to in terms of completion of a task. Satisfaction was expressed when then participant was able to disassemble items. Frustration was expressed when he was not able to disassembly parts in circumstances where he would expect himself to be able to.
>
> The act of discovery was a strong motivator; the participant expressed the initial opening of the outer housings as the most enjoyable part of a teardown.
>
> He likes to use his hands to test the resistance of joints and is also particularly fond of the use of tools.

It is mostly the case that he only elaborates on his emotional experience when specifically prompted. Here are a few examples, extracted from the interview:

> *Sam (S) is currently disassembly the video game controller, he is perform an intricate task with a screwdriver. He has been relatively quiet to this point so requires some prompting from me (D):*
>
> D: you enjoy the fiddly bits - looking for all the screws? Do you enjoy the challenge of taking these apart?
>
> S: Ummm, yeah, you could say so.
>
> D: Put it this way: how does this compare to a mobile phone?
>
> S: Much easier. This is older and older things are generally easier because they're less compact. Over the years, the producers and manufacturers have made things much harder to disassemble. They make things more tamper-proof, like we've talked about, more glueing. It's more of a hassle to disassemble.
>
> *Sam has been struggling to remove a screw from the soda machine for over 3 minutes*
>
> D: Are you still having a nice time?
>
> S: Now it's getting more tedious.
>
> D: At this point, would you have just given up and chucked the whole thing?
>
> S: No. But that's me.
>
> D: Is it because you're invested into it?
>
> S: Yeah, that's the thing. When you've come this far and you only have one screw left, you don't just give up, I guess.
>
> D: OK, but how is this as an experience? I think we've established that it is a little bit frustrating and it doesn't look particularly ergonomic, the way you're making these positions with the screwdriver.
>
> S: No. you're right. And the fact that it's not flat underneath, so you can't push it down on the table.
>
> D: But is it still somehow fun?
>
> S: Ummm, yeah, I would say so. Then again, it's the challenge. But of course, having the right tools [would help] - do you have something we could use?

As an initial pilot study, this workshop offered some useful insights to the observer as to how one might study disassembly and human affectivity. Yet, much refinement of the format of the workshop was required for it to become an effective method of research.

Analysis of results from Workshop 2 - Luis

The next participant to partake in the teardown study was Luis. Luis volunteers at an organisation specialising in the upcycling of discarded products. Like Sam, he was selected for his predisposition toward the end-of-life salvage of products, but without the professional background as with Sam.

Luis was given more products to disassembled, with the inclusion of a keyboard and set of speakers, and was also given the prompt cards to which to refer.

See appendix for transcript. This has been annotated (in the green boxes) with incidents of occurrence

Fig 9

By totalling the amount of incidents when Luis referred to the emotions displayed on the prompt cards (in most cases verbally but occasionally through gesture) it can be seen that not all emotions were relevant, and that some, namely fear, dissatisfaction and satisfaction, occur more frequently than others. Below is a table of the quantity of occurrences of each emotion, those not appearing on the table did not occur.

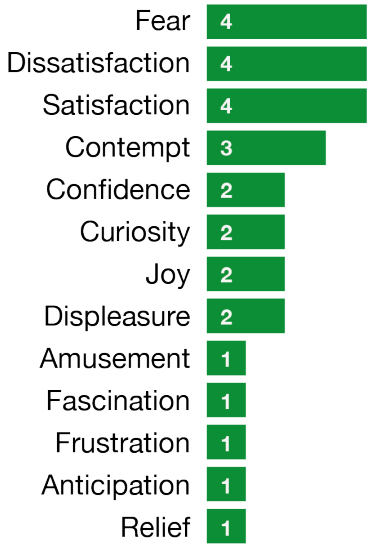


Fig 10

Drawing concrete conclusions by simply counting the references to emotions, however, is not sufficient in this case. Only on some occasions were the references to emotions a direct result of the physical attributes of the product or the disassembly action in hand, as was the aim of the study.

There were other occasions when the references to emotions reflected secondary responses to the disassembly actions or were referred to when discussing disassembly in general rather than the action in-hand. As an example of a secondary reference, in one occurrence, the participant refers to the physical attributes of removing the coffee pot as failing to inspire a decent level of attentiveness which could result in the fear of spilling coffee. In this example, fear is classed as a secondary reference.

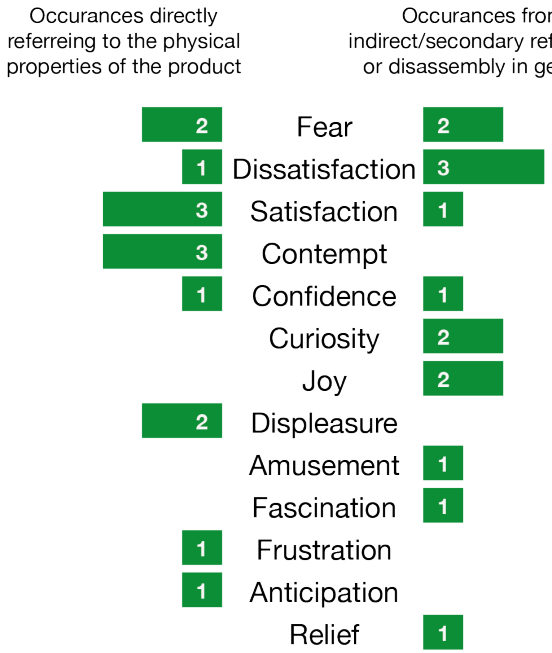


Fig 11

One the one hand, dividing the occurrences into these two groups shows that the format of the study is quite unsuitable for achieving its intention - that is to start to establish firm links between specific disassembly actions and emotional responses. Rather, it illustrates that this format only has limited capability in distinguishing the purely performance based aspects of the practice of disassembly from those at the wider, entity level.

On the other hand, it starts to suggest that certain emotions are more apt in certain situations. Contempt, satisfaction and displeasure seem to be more strongly associated with the physical, performance-based aspects of disassembly, whereas curiosity, joy and fascination appear to be at the generalised level.

The elements of Chapman's six-point experiential framework did appear to be present and relative to the study. Luis was able to occasionally refer to them, using them to explain the reasons behind his actions or emotions. For example, he was able to phrase the reasoning behind his approach to disassembling a laptop in terms of his attachment to the product.

Chapman proposes his framework as a means of providing vocabulary for explaining product-human relationship during a product's use phase (Chapman 2009) and, critically, the passing of time is a factor in these relationships. The dimension of time is not as applicable in the context of acts of disassembly which, instead, could be viewed as a standalone point on a timeline. Therefore, for the purposes of this study, the inclusion of this vocabulary was used to attempt to comment on a more macro or thematic level, unlike the set of Ortiz Nicolas emotions which was chosen to comment on particular actions.

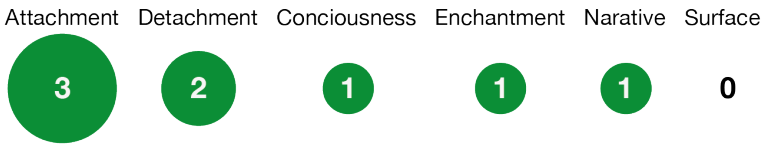


Fig 12

Throughout the discussion with and observation of Luis during the teardown, other pertinent emotions and themes were noticed. These were noted because they were either more relevant than those provided by the prompt cards, or because they described the essence of the situation better than any one particular emotion. These were:

Attentiveness **Confusion** **Valuation and risk**
Uncertainty **Impatience** **Bodily irritation/discomfort**
Intuition **Invitation/Repellance**

Throughout the workshop, two overarching concepts to categorise Luis' correspondence began to emerge. These I have classified as:

Matters of engagement:
factors that inform the participant's choice to undertake acts of disassembly

and

Matters of experience:
factors that influence the participants emotional response whilst undertaking acts of disassembly

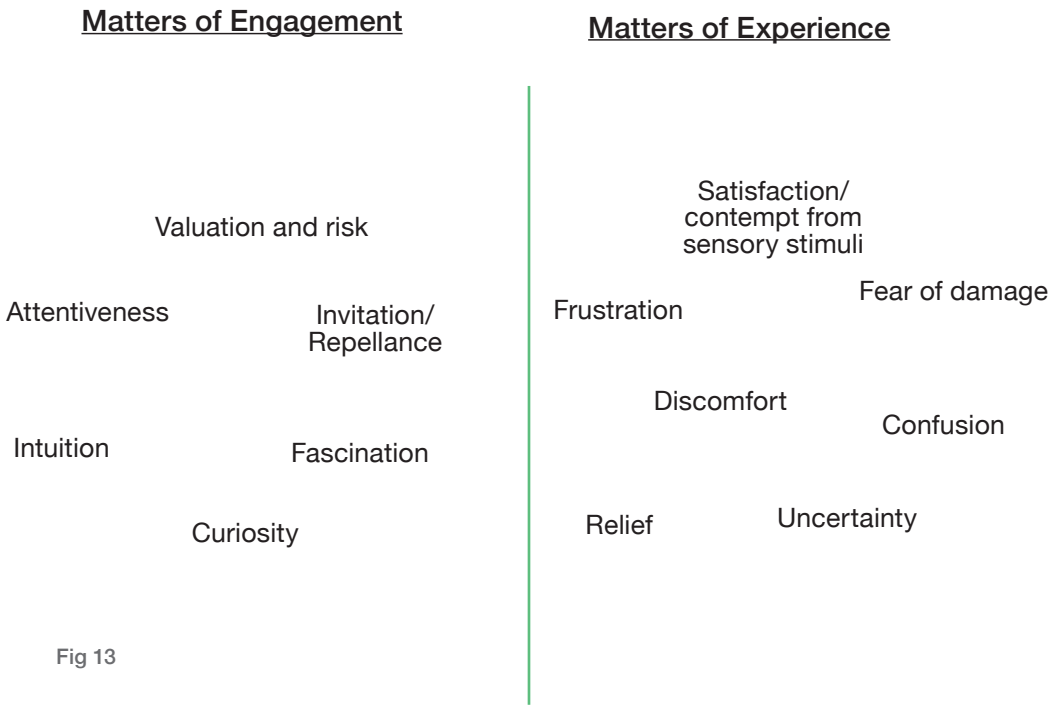


Fig 13

Discussion

In this chapter the findings from the workshops are built upon. I present a supposed conept of Affective Disassembly and discuss its possible contribution to Sustainable Design

It is of utmost importance, as an opening to this chapter, to make clear the infantile state of the research and lack of empirical rigour of the outcomes from the workshops thus far. Everything beyond this point in our discussion should be considered speculation and conjecture, built from glimpses of reasoning for a possible future academic field as offered by the research undertaken. Much development, both in terms of quantity and quality, is needed before the suggestion of Affective Disassembly can be considered grounded theory (Corbin/ Strauss 1990).

With this in mind, it is also important to state that the very nature of this project is to germinate the idea of Affective Disassembly. It was to ask whether the compilation of designing for disassembly, designing for emotional attachment and theories of practice might be combined in such a way as to provide relevance to Design for Sustainability. The content in the remainder of this discussion indicates that I may have stumbled upon a patch of fertile soil in which to seed this idea, yet there is still much help needed from academics and practitioners to test this soil and cultivate the idea.

Introducing Affective Disassembly

There are two key outcomes of this paper.

The first is that there seems to be grounds for a novel area of designing for sustainability, as a subsection of Design for Disassembly. I propose to use the term Affective Disassembly.

The second is that, when studying the practice of manual disassembly of consumer electronic goods, it appears useful to approach the topic with two - somewhat interwoven - perspectives. These are: matters of engagement and matters of experience. The former, encompassing elements relating to the participant's decision to partake in the practice, and the latter, the affects of the practice while the participant performs it. Or, 'how does one feel about disassembly?' and 'how does disassembly make one feel?'

Expanding on Matters of Engagement and Experience

Evaluation of workshops

The research workshops were intended to attain feedback relating to the participants' feelings and emotions during acts of disassembly. To achieve this the frameworks from Ortiz-Nicolas/Demset and Chapman were employed. This gave the opportunity to assess how applicable frameworks and vocabulary for describing consumers' relationships with their possessions are when applied to acts of disassembly.

It was found that the singular emotions from the Ortiz-Nicolas list were not all relevant. Moreover, that while some were certainly present, they tended to be too generic to provide specific insights. The same emotion could be used to describe two quite different scenarios; the fear of snapping plastic housings through the use of excessive force when trying to disassemble a cheap computer keyboard is quite different from the fear of disassembling one's computer hard drive to the point beyond which they feel confident in being able to reassemble it. Chapman's six-point experiential framework also had limited success. Again, its elements were present in the discussion during the workshop but they seemed more adept at providing reasoning for the occurrences of feelings during disassembly as opposed to being the 'unit' of feeling themselves. They certainly seemed more pertinent to matters of engagement than matters of experience.

Upon reflection, a better frame of reference might have been that of Jordan's 'four pleasures'. The elements forming the Matters of Engagement and Experience, extracted from the workshop with Luis, could be bounded reasonably neatly into these categorisations. The Matters of Experience having strong links to: physio-pleasures in the forms of the satisfaction derived from aural stimuli, the discomfort derived from haptic stimuli; and psycho-pleasures derived the feelings of confusion, frustration and fear (even though these clearly reside at the negative end of a pleasure spectrum. It would also be worth reconsidering the satisfaction from a sense of achievement that Sam alluded to during his workshop.)

Further Research: Experience

A range of methodologies exists for measuring the effectiveness of the disassembly of products and prototypes in an industrial context (for Venegas et al. 2017). So too do toolkits for measuring and engineering the human affectivity of products (see Barnes/Lilleford 2007, Bergman 2016). It seems feasible that these methods could be altered to be made applicable to Affective Disassembly.

To speculate upon an example, let's take Peeters et al.'s proposal for the use of elastomer fixings to aid in disassembly. They present a profile of the force required to displace the fixing to the point of release, the success of which was expressed as time. Given that the research workshop with Luis seemed to suggest there is a strong correlation between haptic feedback and satisfaction while performing disassembly, it seems plausible that Peeters et al.'s force tests could be built upon to express a dimension of physio-pleasure.

Further Research: Engagement

Matters of Engagement could be regarded as a much more expansive area. Evident from the workshop with Luis, all three constituent elements of a practice: meanings, competences and materials contributed to his decision to engage with or decline performing acts of disassembly. Closely entwined with these elements of practice were Chapman's notions of emotional attachment. Luis often indicated his decision to engage with disassembly was a balancing or cost analysis between his valuation of the product and his perceived ability to perform the practice. This study barely scratched the surface of what appears to be a complex relationship between Chapman's body of knowledge on meanings relating to possessions and the meanings and competences Practice Theory would suggest apply to the practice of disassembly.

Further exploration and untangling of these connections could prove fruitful to the profession of designing manufactured goods.

It would certainly be insufficient to suggest that addressing Matters of Engagement through product inscription can directly correlate to progression toward a circular industrial economy. This would require a much more encompassing digestion of sociotechnical academia. To name but a few: theories of suffusion of practice (e.g.), Actor Network Theory (e.g.) and theories in sustainable transitions (e.g.). Further exploration of how engagement in Affective Disassembly may fit topologically with these academic fields may be beneficial to understanding its potential contribution to sustainable design.

Practice Theory as a vehicle for discovery

As a final topic in this discussion, I shall comment on how instrumental theories of practice has been in guiding the direction of this project, and how it might continue to be of use to the development of Affective Disassembly.

This thesis has its roots in a curriculum of sustainable design. Though the study of practices has been the focus of this work - and indeed no product design has been 'done' during this term - linking this work to the profession of design should not go ignored.

I reiterate that this proposal for the study of affective disassembly should be seen only as speculation at this point and its relevance is by no means certain. I welcome further academic scrutiny and exploration. If Affectively Disassembly is to have any impact on sustainable design, further academic attention should be a first step. A second, equally important, step is to mobilise this into the design profession. Using the study of practices to continue exploration into matters of engagement and experience - into the human, emotional aspects of disassembly appears to me to be most viable. To illustrate this, please consider these two quotations:

Affects enter into economic practices in the modern market economy, associated with success or victory in competition or the joy of creative work.The question is why this affectivity not only occurs in special cases of social practices but is a general phenomenon.Two main structural properties of practices can be said to require the presence of affects: motivation for the practice and the focussing of attention.

(p119, Reckwitz 2017)

One thing is certain: a sustainable design culture that practises more than just recycling, energy efficiency and design for disassembly must be nurtured. Well-intentioned approaches such as these should be seen as essential components of efficient production and consumption, and they should be practised universally regardless of any environmental claims or ethical righteousness. As a creative discipline, sustainable design is most certainly unresolved and must continue to delve deeper still to the very root of human consciousness, as this is exactly where both the problems of and the solutions to what is essentially a man- made environmental crisis lie.

(p169, Chapman 2015)

Conclusion

In summary, this project has been a first step into understanding how design for disassembly could be conceptualised when considering disassembly as a consumer practice. The outcome of which, has been to suggest grounds for further study into the topic of affective disassembly.

The core of the research gathered came from two participant observation workshops, in which an analysis of consumers' disposition towards acts of disassembly was conducted. The workshops were intended to gauge the participants' emotional and sensorial responses to the physical experiences of disassembly through the verbalisation of their thoughts and feelings during the exercise. Though there was partial success in terms of the participants responding to the actions in hand, it became apparent that just as prominent was the display of the participants' feelings toward the practice of disassembly on wider level - isolating the feelings generated from the immediate experience of disassembly from those forming the participants view of disassembly as an entity was not straight forward.

The feelings and emotions that disassembly instilled in the participants seemed to pertain to two characterisations: matters of engagement and matters of experience. This characterisation is suggest to be of probable importance in the continuation of studies in design for disassembly.

References

Barnes, C.J., Lillford, S.P., (2007) *Affective design decision-making—issues and opportunities*, CoDesign, Vol. 3, Supplement 1, 135 – 146, Taylor & Francis

Bergman, M., (2016) *Affective Surface Engineering for Product Design*, Chalmers University of Technology

Ceschin, F., Gaziulusoy, I. (2016) *Evolution of design for sustainability; From product design to design for system innovations and transitions*, Esevier Ltd.

Chapman, J. 2009. *Design for (Emotional) Durability.* Design Issues, Vol.25(4) p.29 - 35

Chapman, J. (2015) *Emotionally Durable Design; Objects, experiences and empathy*, Routledge

Corbin, J., Strauss, A., (1990) *Grounded Theory Research: Procedures, Canons, and Evaluative Criteria.* Qualitative Sociology, vol 13, no 1 Human Sciences Press

Guest, G., Namey, E.E., Mitchell, M.L. (2017) *Collecting Qualitative Data: A Field Manual for Applied Research*, SAGE Publications Ltd.

Jordan, P.W. (2000) *Designing Pleasurable Products; An introduction to the new human factors*, Taylor & Francis

Moreno, M., De los Rios, C., Charnley, F. (2016) *A Conceptual Framework for Circular Design*, Sustainability 2016, 8, 937, MDPI

Nicolini, D. (2012) *Practice Theory, Work, and Organization: An Introduction*, Oxford University Press Incorporated

Ortiz-Nicolas, J.C. (2014) *Understanding and Designing Pleasant Experiences With Products*, PhD Thesis, imperial College London

Peeters, J.R., Venegas, P., Dewulf, W. Duflou, J.R. (2015) *Economic and environmental evaluation of design for active disassembly*, Journal of Cleaner Production 140, p1182-1193, Elsevier

Peeters, J.R., Venegas, P., Van Der Bossche, W., Devoldere, T., Dewulf, W. Duflou, J.R. (2015) *Elastomer-based fastener development to facilitate rapid disassembly for consumer products*, Journal of Cleaner Production 94, p177-186, Elsevier

Reckwitz, A. (2002) *Toward a Theory of Social Practices; A Development in Culturalist Theorizing*, SAGE Publications

Reckwitz, A. (2017) *Practices and their affects*, in The Nexus of Practices, p114-115, Routledge

Røpke, I., (2009) *Theories of practice — New inspiration for ecological economic studies on consumption*, Ecological Economics, 68, 2490–2497, Elsevier

Shove, E., Pantzar, M., Watson, M. (2012) *The Dynamics of Social Practice: Everyday Life and How it Changes*, SAGE Publications Ltd.

Venegas, P., Peeters, J.P., Cattrysse, D., Tecchio, P:, Ardente, F., Mathieux, F., Dewulf, W., Duflou, J.R. (2017) *Ease of disassembly of products to support circular economy strategies*, Resources, Conservation & Recycling 135, p323–334, Elsevier.

Vezzoli, C. (2018) *Design for Environmental Sustainability; Life Cycle Design of Products*, Springer-Verlag London Ltd.

Watson, M. (2012) *How theories of practice can inform transition to a decarbonised transport system*, Journal of Transport Geography, 24, pp. 488-496

Baldé, C.P., Forti V., Gray, V., Kuehr, R., Stegmann,P. : *The Global E-waste Monitor – 2017*, United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA)

European Environment Agency (2017) *Circular by design Products in the circular economy* EEA Report No 6/2017

World Economic Forum (2019) *A New Circular Vision for Electronics Time for a Global Reboo*t

Repair Cafe Denmark https://repaircafedanmark.dk

UN.org https://www.un.org/development/desa/disabilities/envision2030-goal12.html

Figures

All figures/photographs are produced by the author.

This exclude immage on page 18, fig 6; sourced from stenatechworld.com

Appendix

First, Luis is presented with the coffee machine and the soda machine. Each has an act of disassembly associated with the operation of the product: the repeated removal and then replacement of the coffee pan and water bottle, respectively.
Luis was asked to assess his emotional response to the physical attributes of performing these actions before moving on to attempt to disassemble the soda machine.

L: *Removing the coffee pan.* This is a pretty standard, simple thing. It doesn't offer me anything interesting to do.
Removing the soda bottle. This is a bit tricky. I was trying to twist it but it didn't come out so I had to pull it as well actually. That made me be aware of what I was doing. Between the two of them, I prefer this movement because I have to be aware of what I'm doing, 'OK, now I have to pull', so there is a slight resistance to it coming off.
D: Resistance in the joint?
L: Yeah. It makes me more aware that I'm doing this movement - and I'll be a bit more cautious, so if its carrying liquid, I will not drop it. But with this one [coffee pot] it's like simple, easy, I don't care.
D: So when these are full of liquid, you like the extra attention that you have to give this one [soda bottle] ?
L: Yeah. It makes me feel more safe. Like this one [coffee pot] I might be yawing and drop the whole thing. But this one [soda bottle] it might be not coming off so I have to focus more.
D: So with this one [coffee pot] there's no engagement?
L: Yeah. It's too easy, it just slides out.
D: *Moving the coffee pot in and out.* So is it that there's no registration when it's fully in or when it's out.
L: Yep. But maybe it's meant to be.
D: But that little bit of feedback you get from this one [soda bottle] that says it's locked in place is useful?
L: Yeah.

Opening the coffee machine lid. I am not very sure of this lid - whether I can take it off or not. I'm afraid of breaking it if I put too much strength into it. But I would say that it's also quite a simple movement, it doesn't engage me at all. Also just kind of standard, it doesn't offer me anything [in terms of engagement].
Operating the soda machine lever. And I would say this is pretty standard as well. But I would say that there is another thing, there's a bit of instability in this product. I have to be like this [operates the lever by holding the rest of the item still with his other hand] or something might happen.
D: Which is a little strange. One the one hand, the tight locking mechanism of this [the bottle] joint...
L: ... yeah, makes me assured, but the using of it is tricky.
Re-attaching the soda bottle. Hmm, this is a little tricky because I would like to hold it on the bottom and twist, but the bottom part twist by itself. I don't know why. But again I have to be engaged when putting it in. It can be a good thing, because again you have to be aware or what you're doing - if I'm not paying attention, I might do it wrong. It depends on what it's looking for from me in this situation, should I be engaged in this process?

Contempt - lack of sensory feedback in operating the coffee pot leads to lack of recognition

Dissatisfaction - the difficulty of removing the bottle described as "tricky"

Fear - uses the words "cautious" and "safe"

Confidence - the increased 'safety' the soda machine provides over the coffee machine

Detachment - in general there is a lack of engagement between the person and the product

Attentiveness/awareness - the emotions in this section are heavily influenced by the product's ability to instil a sense of attentiveness in Luis. This does not seem to be representable by the emotion cards on offer.

Fear - uses the term "afraid of breaking"

Contempt - describes the motions as failing to engage him again

Dissatisfaction - the instability of the product is seen as dissatisfactory

Confusion - the counter-intuitive grip position when re-attcaching the bottle puzzles Luis. He phrases in terms of a communication breakdown between himself and the product.

As disassembly of the soda machine commences, I urge Luis to focus on the cards, to choose the relevant ones and elaborate on his choices.

L: Looking at the two together, this one [coffee machine] there's not much to be done with it in terms of disassembly. It seems like one unit. I cannot see many screws or detachable things. But with this one [soda machine] I already see like two lines and different components already. I'm able to twist and dismantle the body .. it comes off quite easy.. even easier than taking off the bottle!
Yeah, the fact that it's modular. Because I am a curious person, I'm a little bit amused by it.
D: So you like to see what is inside of it?
L: Yeah. If it offers me a safe way to come back. That's a big thing. So for instance, like laptops or stuff like that, it's like '[makes a nervous sigh] ummm no I don't want to damage my laptop' but for instance, like a desktop, not so much - you can play better with it because it's meant to be more modular than a laptop.
D: You said 'safe to come back'. So given the opportunity, would you prefer to be able to...?[Disassemble your laptop]
L: Yeah. I come from circumstances where you are born to do a it of everything, so at home I was the 'technician of the house', so I had to fix many things and was always playing with things.
D: On that notion, the reasons for wanting to look inside. You mentioned curiosity already...
Take a laptop, imagine that it was actually possible to take it to pieces and put it back together with very little fear of it being damaged.
L: I would say there's a fascination to understand how things are together. Which is pretty similar to desire. I would desire to know how it is.
D: Do you think it would increase your bond to product if you can do this?... I know it would be different for different products, so let's focus on a laptop.
L: Definitely. To reassemble it and it still works? Definitely. I understand how it works and then I feel like I know the heart of this machine. Almost like it's my girlfriend, haha.
D: Ah OK, so you kind of grow...
L: You could say you grow an attachment..
D: It almost is like consciousness. That you've taken the time to understand this product as a character in itself.
L: Yeah. Enchantment too, at the beginning. I think that it will always start like that because of the curiosity that I have to see how the components work together. And if I'm offered a safe path to kind of understand that and come back from it, then I'm going to feel more attached to it and be more conscious of treating it better. I would also feel satisfied if it comes back working, haha. And after practising a few times, I would also feel confident about taking it apart of putting it back.

Curiosity - wanting to take the product apart

Fear - "safe way to come back". The fear of damaging the products

Amusement - the entertainmment in doing so. Refers to disassembling as playing, in this instance.

Fascination - satiating his curiosity by learning through disassembly

Attachment - states that disassembly can lead to a growing bond

Conciousness - refers to the laptop using the anthropological term of 'girlfriend'.

Enchantment - desribes the increasing attachemtn as the result of a ajourney that would start with mystery

D: Does it give you a sense of power, if you're able to disassemble and reassemble a product?
L: I was very confident with this one because it's not a high involvement or high value product. If I mess it up, all I lose is my water dispenser. If I do it with my laptop, hell I'm losing money and I have to invest in another computer!
D: So there's value in terms that this [soda machine] is a cheaper, but also you have a lot less intimacy with this kitchen appliance than a laptop.
L: Yes, the meaning in both. Because the laptop I use for a lot of stuff, it's a more complex device, and also the financial matters. Those factors play a role in the attachment I feel. And that also means for disassembling. I would rather do it myself, but if it's too high risk, I would take it to an expert.

Luis has spent some time removing screws. He is trying to pull two parts of the soda machine apart by hand but has missed a screw.

D: Using a bit more force now?
L: This thing [the pump handle] feels like it's in the way. Maybe there is some way I can take that off.
Continues to struggle. Physically showing signs of frustration. Then gives up.
L: OK, now I'm disengaged, haha. That was too much.
D: Haha, so that's it? It's had thirty seconds of your time, you can't do this bit, and now you've lost the desire to continue?
L: Yep, haha. It's frustrating me now.
D: So to recap: you tried, you gave a bit of force [with the hands] then it starts to become un-pleasurable and un-satisfying?
L: Yeah. And it feels like I'm going to break it if I use too much force. And It feels like it's not meant to.
After a hint, he realises the remaining screw.
L: Aaaah, I'm missing a screw. Oh Hell.
Attempts to remove the screw for a while whilst not realising the tool cannot reach the screw.
D: Have you lost your curiosity about what is inside here yet?
L: Yeah I'm very close to losing interest in this.
D: OK. So the screwdriver can't actually reach the screw, by the way. I don't have a tool here that can get that undone.
L: Ah right. Yeah, I've lost interest, I'll put it back together. This is a product that doesn't attract me much, because of its use.

D: Imagine you were getting rid of this at the end of its life. Which recycling bin would you put it in? Metals, plastics?
L: Plastics.
D: Imagine, you're trying to be good and consider breaking this down for recycling and you've reached the stage where you are at now. We have a workshop downstairs, would you take the effort to go and get the right screwdriver?
L: Mmm naaah. It's too much work. We also have to remember I'm a busy citizen. So even if I had the things [tools] all the time to sort out the different components of it, it should be easily done, for this scenario. If it is for repair, I would be more likely to push the extra mile.

Confidence - was able to proceed confidently with the disassembly of the soda machine

Attachment - explains a sense of attachment to the laptop, moreso than with teh soda machine

Value and risk - the conversation through much of this section has been focused on how some level of attachment seems to affect decisions and emotions around disassembly.

Frustration - his actions and attitude change to reflect his inability to open the parts.

Dissatisfaction - failure results in a loss of impetus to continue

Detachment - he is unwilling to engage with the product for the scenario of recycling. It does not inspire him to take the time.

Attention - whether the product is able to warrant the investment of Luis' time is thematic in this section

D: So if it's disassembly for the purpose of repair or upgrade, and it has value to you…
L: Yeah [I would do it]. But if its for the sake of sorting [for recycling] it's done with me. What's the value there for me?
D: Does time have a big influence on this?
L: Time - and even if I had the time, I don't have the interest in this, to be honest. I'm a curious guy but with a short patience!

The computer keyboard is presented to Luis next. I ask him to focus on the physical sensations and how these make him feel.
I also ask him to consider a hyperthetical scenario of wanting to clean underneath the keys and ask him to demonstrate what actions he would take.

D: So take this product. This also has an element of disassembly during its use [referring to the removable battery cover.] How does this compare to the tough-to-screw soda bottle and the very light coffee pot?
He removes and replaces the battery cover twice. Then once more, describing the action.
L: Again, no particular effect in the pulling up. Like, it's easy, so I just do it. Then [because it is detached] I might just put this [the battery cover] somewhere and it might take me some time to find later. But, actually, it's satisfying the way it clicks back in.
D: It clicks back in? So is it that resistance again - the confirmation that this is home [as with the soda bottle screw]?…
L: … Boom…
D: …Unlike the coffee pot which would slide in and out with very little registration?
L: Yeah but this is like music to my ears. He repeats the action. 'Boom. Done. You're finished'.
D: So it's the physical feedback and the sound that do that to you?
L: Yep. And it's a signal that I haven't broken it. I'm expecting that sound.

I then task him with imagining he wishes to clean under the keys, and ask him to demonstrate how he would approach doing this.
L: Well, first I know I have to take out the screws. I don't feel particularly anything, but it is quite time consuming. Sometimes it's 'come on - get out already'. Maybe if this was an electric screwdriver.
He removes most screws, then attempts to part the sections of the keyboard using his fingers.
D: Using the fingertips there, how is that?
L: Usual, OK. Maybe a little annoying on the fingers, but OK.
Clicks are heard as the pieces start, but don't continue, to separate.
L: Now that clicking is too much. It's worrying me.
A small plastic piece breaks off from somewhere.
D: That's a different type of clicking?
L: Here's the issue. He goes back to unscrewing the screws.
D: Ah, OK, so you were testing with your hands to see how it feels?
L: Yeah. To see if it was coming off because I'm not sure if these screws are in or not.
He searches for more screws.
This one is still in but it's not coming off.

Contempt - removal of the battery cover is seen as neutral

Satisfaction - the physcal and aural stimulation of the battery cover 'clicking' back into place

Anticipation - states that he was expecting the sound

Displeasure - the sensation on the fingertips is a little displeasing

Fear - the aural sensation is 'worrying'

Uncertainty - he is unsure of the product's state

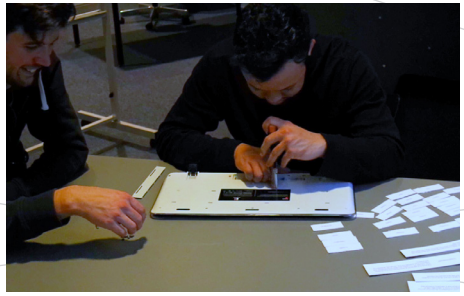
Impatience - has an expectaion of how long unscrewing should take, becomes displeased if it takes 'too long'

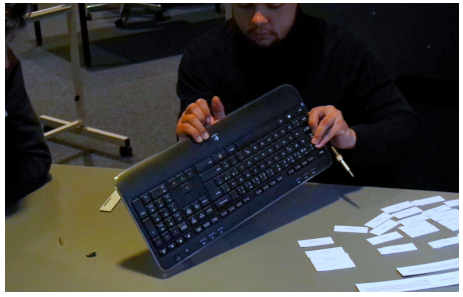
Irritation/discomfort - although referred to as displeasure, it is more accurate to say that the negative sensation on the fingertips is rooted in physical discomfort..

He is distracted and operates the feet of the keyboard. These are hinged parts which offer physical resistance when operating and a release of resistance with a click when the operation is complete.

L: I like this. The clicking again. Like the sound of confirmation.
He attempts to part the pieces again.
L: Hmmm, very scared of breaking this now.
Returns to the screws.
L: This screw is not happening. It's turning but it's not coming out.
I hint at some screws hidden under a label.
D: Might you had struggled to find that?
L: I would have never had found that. Why do they [the designer/ manufacturer] do this? Returning to the problem screw. What's wrong with you, buddy?
He continues with the screws and tires to part the pieces again but without success. He has been attempting this task for a little over 5 minutes by this point.
D: OK. Is it safe to say that you would have given up on cleaning by now?
L: Yes. I would just buy a compressed air can and blow it clean instead.
He starts to fiddle with the keyboard feet again, un-purposefully.
And has another quick try at removing the parts.
L: Now the clicking has stopped. You think it's coming off, but it's not. Not so satisfying.

L: I would say with this product, by the looks of it, it could make me attached. Y'know, it's a bluetooth keyboard, it looks good.
D: How do you mean?
L: I like the shape of it. It's not a boring, standard keyboard. I haven't seen a model like this. That would make me attached to it. It has an identity to it.
D: You can imagine it would be a product that you would have some sort of attachment to it. So would you actually want to clean it if it was getting nasty under the keys?
L: So, I would do as I did now. I would try, and if it's too much - and I would say that this is high risk, because of the attachment I have - so I would just dust it.
D: So you would feel more attachment to this product than the soda machine?
L: Yep. The ideal case would be to clean it, to make it easy. So maybe I just put me nails under somewhere in here points to the front of the keys and just… he makes clicking sound as he gestures opening a panel with his hand, then gestures spraying.
D: So some sort of service hatch?
L: Yeah. Like this [holding up the battery cover] why is it easy to change the batteries but not to clean it?





Satisfaction - again, the physical and aural sensation is pleasing

Dissatisfaction - the unexpected outcome leads to dissatisfaction

Attachment - describes an attachment to the product through aesethetic meaning

Confusion - the screw is behaving unexpectedly

Lastly, the participant was preseneted with a choice of two products. The games console controller and the set of speakers.
For this part, he was given free choice as to which product to disassemble first and to what extent he wished to perform the disassembly. He was not asked to imagine a particular scenario such as recycling, but instead to just follow his interest.

He picks up the gaming controller first.

L: What I find with electronics is that, even though I love to use them, I don't have much knowledge when it comes to disassembling them. That puts up a barrier to me. If I think that it is too high risk, I don't want to screw it up. So if I see, for example, this button
the participant identifies the trigger button, which is malfunctioning physically
it's not working well, I consider this to be an easy thing to solve. Maybe a spring is badly placed. So I would try to open it.
He proceeds to unscrew the controller.

D: You said that you don't know much about electronics - and we've already discussed the laptop - but do you enjoy taking electronics apart?

L: Yeah, I do enjoy it. If I have the right tools.

D: Where does the enjoyment come from?

L: Curiosity. And the satisfaction of taking it apart, putting it back, and it still works. But that risk of messing it up [*makes facial gesture to suggest it is not a good feeling*]. If it's high value or high risk - well, I would say if it is high value then it is high risk also - then probably no. Or unless it's completely dead, then I guess I will pull it apart, try to make it better and then just trash it if not.

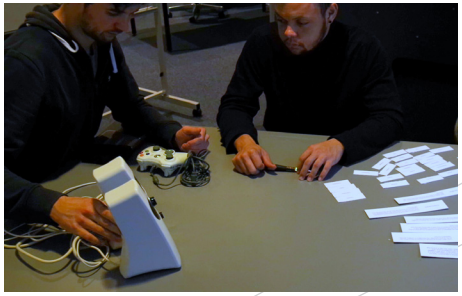
D: Do you know why you picked the controller first?

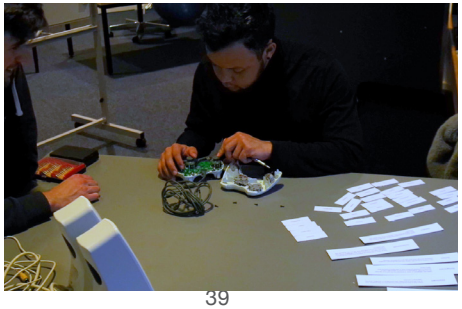
L: Personally because I used to play games, so there's a narrative there, with satisfactory memories of gaming. This has high value for me.

D: You said you like to see what is inside things. Is it fair to say that you wanted to see inside this product more because of that gaming history?

L: Yeah. And I think the speakers might be harder to disassemble. Sound systems I don't know much about. With this [the controller] I know there is a circuit board and buttons, but sound system components I think have a lot more wires.
He parts the two halves of the controller body.
His immediate action is to operate the joysticks and observe the mechanism to which they are attached.

L: So when I see this open, and this is the point where I don't have knowledge. I see this circuit board, but I don't know what to do with it - I cannot interact with it. I cannot read it. And I don't have the tools for it. I know there is current going on here, and that makes the components interact, but other than that it doesn't speak to me. Pointing to one of the vibration motors I know this thing makes the vibration, but I wouldn't know how to pull it apart any more than this.





Joy - he expresses enjoyment in disassembly

Curiosity

Satisfaction

Relief - due to the fear associated with disassembly, relief is experienced if reassembly is successful

Value - the perceived risk involved with disassembly again seems linked to the value Luis associates with the product through his level of attachment.

Narrative - his personal history with gaming is a large influence on his preference of the controlller over the speakers.

Intuition - some components allow the participant to instinctively know how to disassemble them. Others, the circuit board for example, offer him no instinctive guidance.

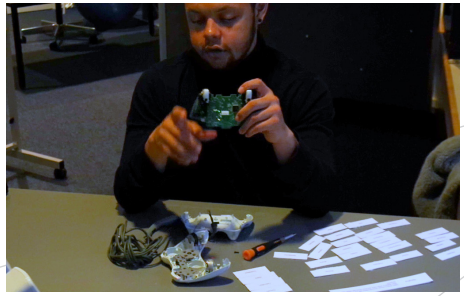
We converse about the salvaging of parts. The participant explains how, in his ideal world, he would salvage parts from products, like the motor, and use them in the repair of others. He determines the primary barrier to this is his lack of knowledge in being able to do so.

D: The concept of taking products apart and salvaging pieces is appealing to you?
L: Yeah.
D: And do you think the design of how the product is disassembled plays a factor in supporting that?
L: Yeah. If the design was more intuitive or instructive. So like I loved Legos because they were easy, but what I loved the most was that they had a guide book. I would always follow the guide book and and get the outcome. So if products could have something of the same, explaining on themselves, that would be nice. That would be more engaging for me. Because now I'm doing stuff but I don't actually know what I am doing, I'm not learning.

He continues til the controller has been separated into 5 main pieces.

D: As a disassembly, how was this? You've got it down to the point where you've pretty much identified the problem [of the malfunctioning trigger button] and it hasn't taken you long. This compared to the soda machine…
L: …it feels very satisfactory, the way I was able to get so far with it.
D: They way this came to pieces, was it very intuitive?
L: I don't think so. As you saw, I was struggling to pull the two halves apart a little. I'm comfortable up to this point, but beyond here, I don't think I would be able to get it back [to a working state]. I have attachment to this, so I don't want to break it.

I present the speakers to Luis.
D: How do these compare to the controller?
L: These are less inviting. I don't see a way to disassemble these. Right away I don't see any screws. I don't see how these are put together.
He feels and picks at the join lines on the plastic housings of the speakers with his finger tips.
D: You have your fingernails in that gap?
L: Yes, but it is not very pleasant. Not comfortable. It's locked off, not to be opened.
After only a short while, the participant chooses to cease attempting to disassemble the product having not been able to remove any parts.



Joy - described as 'love', he recalls the enjoyment experienced when assemmbling Lego

Satisfaction - he expresse satisfaction at the extent to which he was able to disassembly the controller

Displeasure - the physical sensation on the fingertips is displeasurable

Intuition - describes a lack of intuition as leading to a struggle to separate the pieces

Invitation/Repellance - the speakers' form repels Luis from attempting to disassemble them