Integration of EcoDesign principles within small product design consultancies

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ABSTRACT

Each year in the UK (United Kingdom) hundreds of millions of consumer products are sold, leading to many millions of tonnes of waste being buried or burned annually. While there are many large businesses that produce consumer products, in the UK small product design consultancies (SDCs) make up approximately half of all employed designers. This thesis outlines an investigation into the absence of an EcoDesign agenda in product design briefs and how this might be changed in the future.

In order to best establish the theoretical basis of the research, a comprehensive literature review was conducted into the practice of product designers, their relationship to society and the wider environment. In addition, existing tools and resources purporting to support product designers, with the implementation of EcoDesign projects, were analysed to understand the challenges associated with their design. Following this review, and the development of relevant research questions, a series of semi-structured in-depth interviews were conducted to understand SDCs better, how these organisations conduct their business, and how familiar they are with EcoDesign. A series of semi-structured in-depth interviews were conducted with 26 participants from 22 different consultancies. As a result of these interviews, a greater understanding of the barriers and drivers SDCs face in the practice of EcoDesign was established. This led to the creation of d.eco a web-based resource, to facilitate the implementation of EcoDesign principles in SDCs. This resource was evaluated in the final stage of the research.

The majority of product designers had an awareness of EcoDesign and considered that they would be able to use their skills to find the information necessary to create products with a reduced environmental footprint. A significant barrier was that EcoDesign principles could only be legitimately applied when the design brief required their use. However, briefs are not created solely by clients; they were found to be much more collaborative, thus offering designers an opportunity to influence their own briefs. So, the role of an EcoDesign resource is less about assisting the design process, like most existing tools, and more to do with the providing designers with a wellspring of inspiration. However, the resource stimulates more than just creativity. It also provides peer recommended examples of existing EcoDesign products, materials and processes, facilitating the long-term absorption of relevant information. By presenting relevant material, in an appropriate way, designers can be more confident when including EcoDesign criteria and associated principles within their briefs.
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Finally, I am hugely grateful to my wonderful family, for their endless patience, love and unconditional support in all my pursuits, no matter how long they take.

“[W]e had access to too much [information], too much [time], and little by little we went insane.” Francis Ford Coppola
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1. INTRODUCTION

This chapter introduces the general context of the research and the problem that it addresses. The aim of the research is established along with the research questions that the study intends to answer. It also introduces an outline of the structure of the thesis with a brief description of the contents of each chapter.

1.1 Background of Research

Though there may still be some that dispute the effects of human production and consumption on the planet, it is undeniable that many millions of tonnes of municipal waste is burned or buried in the United Kingdom (Defra, 2007) and around the world (OECD, 2008) each year. Given that most of our natural resources are finite, this practice cannot be sustained indefinitely. Since the first wave of Ecological Design in the 1960s many different writers and thinkers have described how to change the way products are created and more widely how society should transform to reduce its environmental impact. Earlier writers such as Vance Packard (1960) and Rachel Carson (1962) often focused on bringing the environmental impact of industrial activities to wider attention rather than working with commercial interests to make change. Awareness continues to play a major role in moving EcoDesign forward, but since the 1990s many have realised the importance of engaging with business and government. More recently Sustainable Design and Sustainability have become popular terms to describe this approach, and they encompass more than EcoDesign. Sustainable Design considers social equality in addition to environmental issues and economic viability. In this context social equality refers to the importance of considering the social impact of products and the steps necessary to advance sustainable development (Madge, 1993). EcoDesign is not concerned with wider social equality. This is not to say that EcoDesign has no social agenda, but it is more localised and is not concerned with the broader issues covered by Sustainable Design (Sherwin, 2000). This project focuses on EcoDesign, in part to simplify the conversation with product designers, because with so few examples of EcoDesign in production it was felt that the transition from current practice directly to Sustainable Design was too great. Also, Sustainability has become part of general parlance, so the term Sustainable Design is often used when another word would be more accurate. EcoDesign is more clearly defined, and in the minds of designers, it correlates better with its expected meaning. It is essential to clarify what any individual means when they use one of these terms.
This investigation focuses mainly on product designers and the structures that surround the creation of manufactured goods and in particular, the work done in small design consultancies (SDCs). While many large businesses produce consumer products, collectively small design consultancies play a significant role in the development and creation of consumer goods. SDCs make up approximately half of all employed designers and generate as much turnover as in-house design teams in the UK (Design Council, 2005). The research has investigated the absence of an EcoDesign agenda in many design briefs and how this might be changed in the future.

1.2 Context of Research

Many important decisions are not taken by designers, but by their clients and managers who often control the general direction of design (Stevenson et al., 2011a). However, despite these limitations, designers can still be observed influencing outcomes and inspiring others through their work. Design consultancies are organisations that plan and carry out design work for clients; this can include generating new ideas, as well as developing and realising existing ones. Their activities can range from assessing the viability of an idea to designing market-ready products and involve all parts of the process from market research to developing concepts, engineering the final design and overseeing final manufacture. Design consultancies often also carry out speculative work based on their own ideas and can have employees with a very broad range of skills and interests. Given that these consultancies contribute so significantly to the overall business of design in the UK, it is important to consider them and the ecological impact of their activities.

Small and medium-sized enterprises (SMEs) are defined by the European Commission (2005) as those with fewer than 250 employees. However, this term is too broad in the context of design companies because it covers 94 percent of these types of businesses. In addition, 59 percent of design consultancies employ fewer than five people, and a further 23 percent employ only five to ten (Design Council, 2005). It was decided that it would be useful to restrict the size of companies studied in order to moderate differences in their practice. Freelance designers were not considered because many of the issues under consideration were associated with group dynamics and communication. At the other end of the spectrum, in-house designers working in corporations are known to have limited control over some important aspects of the design process, such as the brief (Dewberry, 1996; Sherwin and Bhamra, 1999), so were
also excluded. In this report, the phrase small design consultancy (SDC) refers to companies that have more than one, but fewer than 50 employees, which means that around 60 percent of UK based design businesses (Design Council, 2005) are still covered by this the term. The challenges that designers face, in the context of their impact on the environment, have been known for many years and research was being conducted in this area at least twenty years ago. A clear description of some of the barriers and drivers of EcoDesign were brought together by Brezet and van Hemel (1997). However, recent research by the UK Design Council revealed that designers still do not consider that their ability to provide environmental advice is important to clients, with only 16 percent of design consultancies believing it is a major factor for winning work (Design Council, 2010).

To better understand this subject, and particularly in the context of SDCs, studies were conducted into how these organisations conduct their business, what sort of restrictions they operate under, and how familiar they are with EcoDesign.

1.3 Funding

The research presented in this thesis was funded through a Doctoral Awards Scheme studentship from the Arts and Humanities Research Council (AHRC).

1.4 Research Aim and Objectives

1.4.1 Research Aim

The aim of this research is to investigate ways to increase the integration of EcoDesign principles within UK based small product design consultancies.

1.4.2 Research Objectives

- To determine current practice and critically review the use of EcoDesign tools in industry.
- To identify the limitations of existing tools and why they are not more widely used.
- To understand the needs and aspirations of product designers when undertaking EcoDesign.
Chapter 1 | Introduction

> To develop the requirements for an EcoDesign resource that has the potential to overcome these limitations.

> To create a prototype resource and refine it through an iterative process of user trials, modification and re-testing.

1.5 Background of Researcher

The researcher began his interest in design and the environment nearly 20 years ago when he was studying Mechanical Engineering as an Undergraduate at Imperial College, London. A module called ‘Design for Engineers’ was attended as part this course that not only developed design skills but also required a dissertation to be written on a design topic. Having read Design for the Real World (Papanek, 1971) around this time, sustainability and ‘design for need’ became the subject of the report. Having been enthused by design a greater knowledge of this area was sought and led to a post-graduate course at the Royal College of Art (RCA). The Industrial Design Engineering course at the RCA recognised the importance of engineering knowledge while developing the way that students considered their work. A bursary was provided by Dyson Limited to help fund study at the RCA, and this included the invaluable opportunity of working at Dyson during the summer break. Graduation from the Royal College of Art was followed by a two-year position as a Research Associate at the Helen Hamlyn Centre, a multi-disciplinary centre for inclusive design. This involved working with GlaxoSmithKline on medicine packaging that aids patients when taking prescribed drugs. The researcher then returned to the RCA as a part-time MPhil student investigating the design of environmentally sustainable products. The full-time research was facilitated on the receipt of a Doctoral Award bursary from the AHRC. At this point the researcher moved to Loughborough University to continue his studies for a PhD, the topic of his research was ‘Integration of EcoDesign Principles within Small Product Design Consultancies’ and can be read below. In addition to doctoral research, having a degree in Mechanical Engineering led to being involved in the teaching of mechanics across a number of modules for first and second year undergraduates.

Having been at Loughborough University for a few years the researcher also worked on a number of projects, initially as a Research Assistant working on an EPSRC (Engineering and Physical Sciences Research Council) funded Feasibility Account investigating novel means for upgrading consumer products so that their owners would want to use them for a longer period of time. This led to a Research Associate position
on the CLEVER (Closed Loop Emotionally Valuable E-Waste Recovery) Project. This was a multidisciplinary research project also funded by the EPSRC that was a collaboration between several UK Universities: Newcastle University, University of Bath, University of Oxford and University of Surrey. The CLEVER Project aimed to assist in a transition from the current throw-away society to a new model that shifts the focus from designing and selling physical products to a more sustainable system of goods and services. Some of the main areas investigated by this project were Product Longevity and Obsolescence; Purchase Behaviour; Economics and Consumption; and the Emotional Response to Products.

Three years ago the researcher joined the Faculty of Environment and Technology at UWE Bristol as a Senior Lecturer in Product Design Engineering. Part of this role includes teaching Sustainable Design across all levels, from Foundation to Master’s students. The researcher is currently Programme Leader for BA(Hons) Product Design.

1.6 Structure of Thesis

Chapter 1 | Introduction

This chapter introduces the general context of the research and the problem that it addresses. The aim of the research is established along with the research questions that the study intends to answer. It also introduces an outline of the structure of the thesis with a brief description of the contents of each chapter.

Chapter 2 | Literature Review

This chapter explores the literature surrounding EcoDesign and product design consultancies. It introduces a number of existing EcoDesign approaches and tools that are currently available and explains why they are not necessarily appropriate for small design consultancies. Finally, this chapter identifies five research questions that will be addressed through this research project to further the understanding of the needs of SDCs when they are participating in EcoDesign.

Chapter 3 | Research Methodology

This chapter outlines the overarching strategy used to conduct the research. It describes the individual research methods and analysis techniques that were used and
demonstrates how the different research phases were brought together to fulfil the aims and objectives established in Chapter 1.

Chapter 4 | Study of Small Design Consultancies
This chapter presents the findings of the Pilot Study and Main Study, which were conducted using in-depth interviews. The Pilot Study was used to refine the interview questions, with the aim of answering relevant research questions, to better understand the way in which Small Design Consultancies manage and implement their design projects.

Chapter 5 | Resource Development and Testing
This chapter describes how the findings from both the literature review and the empirical studies were used to design and develop the prototype EcoDesign resource d.eco. The resource was conceived to remove some of the barriers that SDC designers face when trying to develop and execute EcoDesign briefs.

Chapter 6 | Resource Evaluation
This chapter presents the findings of the d.eco resource evaluation study, which was conducted using online questionnaires. This was carried out to gain feedback from SDC designers and confirm whether the guiding principles used to create it were appropriate and if it embodied the findings of the Main Study.

Chapter 7 | Discussion
This chapter discusses the findings and results of the previous chapters, responding to the research questions proposed and presenting the final analysis of interesting insights arising from the studies undertaken.

Chapter 8 | Conclusions and Further Work
This chapter draws together the conclusions reached from the work presented in this thesis. It reflects on how the aim and objectives have been met and presents the contribution to knowledge made by this study. The limitations of the work and recommendations for future research are discussed at the end of the chapter.
2. LITERATURE REVIEW

This chapter explores the literature surrounding EcoDesign and product design consultancies. It introduces a number of existing EcoDesign approaches and tools that are currently available and explains why they are not necessarily appropriate for small design consultancies. Finally, this chapter identifies five research questions that will be addressed through this research project to further the understanding of the needs of SDCs when they are participating in EcoDesign.

2.1 Introduction

Rather than retelling the oft repeated history of EcoDesign, the following definition will be used in this thesis.

_EcoDesign is “design which addresses all environmental impacts of a product throughout the complete life cycle of the product, whilst aiming to enhance other criteria like function, quality, and appearance.” (Dewberry and Goggin, 1996, p.12)_

EcoDesign has existed for more than twenty years but has not seen widespread uptake by practising designers (Martinez and English, 2015) something which is reflected in the relatively low number of such products available to buy. This will we discussed in more detail later in the chapter, but much of this is because existing tools do not match the working culture of designers or their creative process (Durling et al., 1996; Lofthouse, 2017).

2.2 Product Design Consultancies

The role of industrial/product designers has evolved over time, but fundamentally their job has always been to design products that meet the needs and desires of consumers at a price they are willing to pay (Cooper and Press, 1995; Sparke, 1983). Historically this would have been a process that started with a brief provided by a manager or client. However, in the last twenty years, design consultancies are increasingly being hired because they understand consumers and their needs, meaning that they collaborate with clients in the brief creation process (Feldman and Boult, 2005).
In general product, designers can be considered to fit into two categories, which are those who work in-house for large manufacturers or those who work in consultancies (Heskett, 2005). In the UK the design industry is overwhelmingly characterised by small design consultancies, 82 percent of design consultancies employ ten or fewer people. However, although there are more design consultancies than in-house teams, the in-house teams are larger, so a similar number of designers are employed in each sector (Design Council, 2005).

Figure 2.1 shows a diagram created by Stevenson (2013) that positions design consultancies in the wider context of product creation and use.

The figure shows some of the complexity and the large number of stakeholders that are involved in the lifetime of a product. The four core elements of the illustration are:

1) The design consultancy made up of product designers, which in this context would be more than one, but fewer than 50 employees. The diagram also includes external specialists that could be brought in where additional skills are required.

2) The client, which is likely to be a company, though could be a private individual. Shown are a number of different departments involved in addition to designers, such as engineers, marketing and management.

3) There are the final customers or users who purchase and utilise the products.

4) Other influences external to the main activities of consultancies include the economy, legislation, commercial trends, and technological advances.
Each consultancy is different, with their own motivations and capabilities, but Figure 2.1 provides a good overview of how small design consultancies work and the context within which they operate.

2.3 Unsustainable Consumption and the Linear Economy

The current western economic model is built on ideas of neoclassical economics and its theories of consumption (Mont, 2007). Neoclassical economics is based on the premise of supply and demand, and this is considered to determine levels of production, prices and income (Mont, 2007). Neoclassical economics is also built upon on three assumptions, as shown in Table 2.1, which are used to simplify economic analysis. However, the idea that consumers necessarily act as rational actors is challenged by some economists (Tukker et al., 2010) evolutionary psychologists (Jackson, 2002; Jackson, 2005a) and, consumer experts (Solomon et al., 2013). The second assumption asserts that the goal of companies is to maximise their profits, and that of consumers is to maximise their utility, or well-being (Jackson, 2005a), which is usually considered by economists to be synonymous with consumption (Mont, 2007). The third assumption has also been criticised because individuals and organisations often neither have access to nor the cognitive ability to effectively analyse, all the relevant information (Mont, 2007).

Table 2.1: The Three Assumptions of Neoclassical Economics (Mont, 2007, p.15)

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Assumption</td>
<td>People are rational actors who have rational preferences.</td>
</tr>
<tr>
<td>Second Assumption</td>
<td>Individuals maximise their utility and companies maximise their profits.</td>
</tr>
<tr>
<td>Third Assumption</td>
<td>People act independently on the basis of full and relevant information.</td>
</tr>
</tbody>
</table>

Whilst there is criticism of neoclassical economic theory, it is still the foundation on which many governments run their economies (Jackson, 2002; Mont, 2007). This belief that growth is good, and that ever increasing gross domestic product (GDP) is the key indicator of better living standards and increased well-being, has led governments to perpetuate policies that do not ultimately improve the welfare of their people (Cooper, 1999; Jackson, 2005a; Mont, 2007). This is because the link between material wealth
and happiness is not linear, and once a certain level of affluence is achieved well-being can level out or even fall with increasing GDP (Kahneman and Krueger, 2006; Mont, 2007; Porter et al., 2014; Shah and Marks, 2004). Although some governments were involved in establishing measures of subjective well-being before the financial crisis of 2008 (Kahneman and Krueger, 2006) the current lack of economic growth has focused attention on these alternative measures of utility. However, despite the reasons described above, policy-makers still consider economic growth and an annual increase in GDP to be the key standard of living indicator (Porter et al., 2014).

The political goal of continuous economic growth is not only the conventional wisdom, but it also depends heavily upon intensive energy and material use in both the production and consumption phase (Mont and Bleischwitz, 2007). In order for this linear economic model, see Figure 2.2, to work it must also be assumed that there is an unlimited supply of natural resources and that the planet has a limitless capacity to assimilate the waste created by these processes (Cooper, 1999).

Figure 2.2: Linear Structure of the Industrial Economy (Stahel, 1998, p.31)

Despite living on a finite planet, the appearance of unbounded capacity can be achieved by shifting production and disposal to developing countries (Schor, 2005). However, although it was apparent many decades ago that a linear economy is unsustainable (Stahel and Reday, 1976/1981) it is problematic to separate resource throughput from a linear economy because it would slow down economic growth, and this would undermine ‘growth is good’ policies (Stahel, 2010). The processes described above do not consider the full life cycle of consumer goods because they start with a definition of need and finish when the product is sold. This leaves several stages neglected including installation, use and disposal.

A cradle-to-grave approach is the “systematic integration of environmental considerations into the design process across the product life cycle, …from raw materials acquisition, through manufacturing, distribution and use to final recycling and disposal.” (Bhamra, 2004). A cradle-to-grave approach is a definite improvement over end-of-pipe attitude, which does not consider the environmental problems of production until after they have occurred (Roy, 2000). However, as Figure 2.3 shows,
there is a gap in the life cycle where the ‘natural environment’ is required to act as the source of our materials and the sink for our waste. An alternative to linear economic model is the circular economic model, see Figure 2.3, and there have been numerous incarnations of this over the decades (Stahel and Reday, 1976/1981; Hawken et al., 1999; McDonough and Braungart, 2002; Ellen MacArthur Foundation, 2015b).

While the more recent models focus mainly on biologically inspired production models and completely closed-loop, cradle-to-cradle, industrial cycles (McDonough and Braungart, 2002) the earlier proposals accept that the loop can never be completely closed and that there will always be some level of waste produced. Also, given the lack of movement away from a linear economy, any progress towards a fully closed-loop system is likely to transition through a less waste stage before reaching a no waste cyclical biological system. On its own, a circular economy, that is not entirely closed
may not be enough to realise a sustainable system if the consumption of resources continues to increase this could offset any improvements in efficiency (Cooper, 2010). A cradle-to-grave approach is the “systematic integration of environmental considerations into the design process across the product life cycle, ...from raw materials acquisition, through manufacturing, distribution and use to final recycling and disposal.” (Bhamra, 2004). A cradle-to-grave approach is a definite improvement over the linear, end-of-pipe attitude, which does not consider the environmental problems of production until after they have occurred (Roy, 2000). However, as Figure 2.3 shows, there is a gap in the life cycle where the ‘natural environment’ is required to act as the source of our materials and the sink for our waste. As long as there is a gap in this cycle, we are ultimately using up the finite resources of a finite planet, more slowly on the cradle-to-grave path, but still consuming more than we put back in.

2.4 Approaches to EcoDesign

Since the first wave of EcoDesign in the 1960s many different writers and thinkers have described how to change the way products are created and more widely how society should transform to reduce its environmental impact. Earlier writers often focused on bringing the environmental impact of industrial activities to wider attention rather than working with commercial interests to make a change. Awareness continues to play an important role in moving Ecological Design forward, but since the 1990s many have realised the importance of engaging with business and government.

Some of the following approaches are based on a central philosophy, while others claim a more scientific background or to have developed from practical experience. However, most techniques are a mix of all these things, but with more emphasis put on one area.

2.4.1 The Natural Step

At the beginning of the 1990s Dr Karl-Henrik Robèrt, a Swedish oncologist, worked with the physicist, Dr John Holmberg, to define a set of sustainability guidelines based on the laws of thermodynamics and natural cycles. 2.4.1 The Natural Step (TNS) aims to create a common language and model of sustainability that can be shared across organisations, backed with broad but non-negotiable system conditions. The Natural Step system conditions (Robèrt, 1997) are:
Extracted substances from the Earth’s crust must not systematically increase in the biosphere.

Substances produced by human society must not systematically increase in the biosphere.

The productivity and biodiversity of the Earth itself must not systematically be physically deteriorated.

Human needs must be met with a fair and efficient use of the energy and other natural resources.

TNS has been widely adopted by many organisations and has been used as a stepping stone for the creation of some approaches in the following sections. This is due in part to the legitimacy created by its ostensive scientific grounding, though it is hard for anyone creating new products to adhere to Conditions 1 and 2 without a liberal interpretation of the word ‘systematically’ (Upham, 2000). However, if The Natural Step is considered to be more of the description of what should be aspired to, giving advice on how to get there, it makes sense in the real world. The Natural Step leaves organisations to determine how to implement the sustainability principles, providing guidance rather than rules:

1) Reduce and eventually eliminate our contribution to the systematic accumulation of materials from the earth’s crust.

   This means substituting our use of certain minerals that are scarce in nature with others that are more abundant, using all mined materials efficiently, and systematically reducing our dependence on fossil fuels.

2) Reduce and eliminate our contribution to the systematic accumulation of substances produced by society.

   This means systematically substituting certain persistent and unnatural compounds with ones that are normally abundant or break down more easily in nature, and using all substances produced by society efficiently.
3) Reduce and eliminate our contribution to the ongoing physical degradation of nature.

This means drawing resources only from well-managed eco-systems, systematically pursuing the most productive and efficient use both of those resources and land, and exercising caution in all kinds of modifications of nature, such as over-harvesting and the introduction of invasive species.

4) Reduce and eliminate our contribution to conditions that systematically undermine people’s ability to meet their basic needs.

This means offering products and services and changing practices, suppliers, and business models to those that ensure that human rights are respected, income-making barriers are removed, safe and healthy work environments are provided, and living conditions allow local communities to meet the needs of citizens.

2.4.2 Factor X

This concept was born from concerns about exponential growth in population and consumption in a world of finite resources. It was raised by the Club of Rome global think tank in The Limits to Growth (Meadows et al., 1972). The Fossil Makers (Schmidt-Bleek, 1993), proposed that “the economies of the countries in which, or for which, most of the material flows are presently moved would have to dematerialise by an average factor of ten in order to allow for a reduction in global material flows by fifty percent.” This was followed in 1994 by the foundation of the international Factor Ten Club, whose “agenda include policy and legal approaches to dematerialisation; changes in economic and cultural priorities; increasing resource productivity through lean technology and changing consumption patterns.” (Factor 10 Institute, 2008).

Factor Four: Doubling Wealth, Halving Resource Use (Weizsäcker et al., 1997) popularised the term Factor 4 and was concerned largely with improvements in eco-efficiency. Factor 4 suggests examples where fourfold improvements in energy, materials and transport productivity can be made through largely technical means.

There are many other proponents of Factor X, with values of X up to 50, though with a longer outlook looking to improve technology a hundred years in the future (Reijnders, 1998). Reijnders sites a commonly used formula as: environmental impact = (population) x (GNP per capita) x (a technology factor). In relation to this most Factor
X advocates concentrate on the ‘technology factor’, however, if population and affluence are ignored, they can swamp any scientific progress. So, exponents, including von Weizsäcker (1997) and his collaborators suggest that prices should be managed, by means such as taxation, to achieve the desired Factor X.

2.4.3 Natural Capitalism

Natural Capitalism describes four types of interlinked principles that an economy needs to function properly. The four types of capital (Hawken et al., 1999) are shown below.

- Human Capital, in the form of labour and intelligence, culture, and organisation
- Financial Capital, consisting of cash, investments, and monetary instruments.
- Manufactured Capital, including infrastructure, machines, tools, and factories
- Natural Capital, made up of resources, living systems, and ecosystems services.

Natural Capitalism refers to the service that the ecosystem provides and that its economic value should be taken into account in business practice. Four major shifts in business are suggested (Lovins et al., 1999)

- Dramatically increase the productivity of natural resources.
- Shift to biologically inspired production models – such as closed-loop production systems.
- Move to a solutions-based business model – value put into the flow of services, e.g. providing illumination rather than selling light bulbs
- Reinvest in natural capital – business investing to restore, sustain and expand the ecosystems of Earth.

Having described the four major shifts that business would need to make in order to change the nature of economic development, there is little reference to real world implementation in Natural Capitalism. Though this is discussed to some extent in earlier work The Ecology of Commerce (Hawken, 1993). Advocates of Natural Capitalism have
gone onto expand their ideas and provide advice to companies as consultants (Russo, 2002). However, the thinkers in the following sections do describe steps towards wider use of these ideas in industry. When looking to realise Natural Capitalism, implementing whole-system-design (WSD) was a necessary part of the roadmap (Lovins et al., 1999). A WSD approach encourages stakeholders to consider problems as a whole system rather than focusing on one particular part of the process (Coley and Lemon, 2009). This is important because it recognises the interdependence of, in this context, all steps in the life of a product from brief creation to disposal or reuse. This level of thinking offers opportunities, like dematerialising products and creating a service or product-service system (PSS) which could otherwise be overlooked by stakeholders who only focus on one aspect of the life cycle of a product (Charnley et al., 2010).

Table 2.2: Taxonomy of Design Approaches for a Sustainable Industry (De los Rios and Charnley, 2017, p.111)

<table>
<thead>
<tr>
<th>Approach</th>
<th>Focus</th>
<th>Strategy</th>
<th>DFx / Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHOLE SYSTEMS DESIGN</td>
<td>SUSTAINABLE SYSTEMS</td>
<td>Radical Innovation for Sustainability</td>
<td></td>
</tr>
<tr>
<td>DESIGN FOR ENVIRONMENT (PREVENTIVE)</td>
<td>ENERGY CONSERVATION</td>
<td>Reduced Environmental Backpacks</td>
<td>Design for Supply Chain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean Energy Consumption</td>
<td>Design for Manufacturing and Assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Material Selection for Sustainability</td>
<td>Biomimicry</td>
</tr>
<tr>
<td>DESIGN FOR LIFE CYCLE</td>
<td>DESIGN FOR EXTENDED LIFE (LONGER LIFE CYCLES)</td>
<td>Design for Reliability</td>
<td>Design for Quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design for Maintenance</td>
<td>Design for Repair/ Refurbishment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design for Reuse</td>
<td>Design for Upgrading</td>
</tr>
<tr>
<td></td>
<td>DESIGN FOR END-OF-LIFE (MULTIPLE LIFECYCLES / CRADLE TO CRADLE)</td>
<td>Design for Component Recovery</td>
<td>Design for Remanufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design for Material Recovery</td>
<td>Design for Recycling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Design for Cascaded Use</td>
</tr>
</tbody>
</table>

Although WSD is not discussed further here, its relationship to life cycle thinking and cradle-to-cradle, which are discussed below, can be seen in Table 2.2.
2.4.4 Five Capitals Model

The Five Capitals Model was developed by the Forum for the Future.

![Five Capitals Model Diagram](image)

Figure 2.4. The Five Capitals Model (Forum for the Future, 2009)

It is very closely linked to Natural Capitalism and the four types of capital it describes, as can be seen in Section 2.4.3 above. The additional capital in the Five Capitals Model is Social Capital. Social capital is: “the value added to any activity or economic process by human relationships and co-operation.” (Wilsdon, 1999). The Five Capitals framework is intended to be used by organisations to develop an understanding of what sustainability means in the context of their own operation.

2.4.5 Cradle to Cradle

The only way to bridge the life cycle gap described in Section 2.3 is with closed-loop production systems, where “every output either is returned harmlessly to the ecosystem as a nutrient, like compost or becomes an input for manufacturing another product.” (Lovins et al., 1999) This idea that “waste equals food” is the first principle of what William McDonough, Michael Braungart and Paul Hawken call the Next Industrial Revolution (McDonough and Braungart, 1998). This move away from the design of cradle-to-grave products towards a more holistic and sustainable approach to design is called cradle-to-cradle design (Chick, 1997). Cradle-to-cradle was a term
coined by architect William McDonough and chemist Dr Michael Braungart (2002). In many ways it follows from Natural Capitalism, focusing mainly on biologically inspired production models and closed-loop industrial cycles, rather than the linear model shown in Figure 2.2. The book considers how nature uses ‘waste as food’ and describes this cyclical biological system as cradle-to-cradle. Material inputs and outputs are seen either as technical or biological nutrients. Technical nutrients can be recycled or reused with no loss of quality, and organic nutrients can be composted or consumed. An analogy is made in the book with a tree whose leaves fall to the ground, the nutrients flow back to nature and bring new growth. McDonough and Braungart then consider how this principle could be applied to the more common cradle-to-grave model, where most resources ultimately reside in landfill. Figure 2.5 shows an example of a cradle-to-cradle closed-loop life cycle for clothing.

Figure 2.5: Cradle to Cradle® Framework (MBDC, 2005)

Cradle to Cradle includes a chapter called “Putting Eco-Effectiveness into Practice”, which describes ‘Five Steps’ to create real cradle-to-cradle systems. These have been put into action to create a certification system that recognises products and processes that follow these criteria. The Cradle to Cradle Products Innovation Institute administers the Cradle to Cradle Certified™ Product Standard (Cradle to Cradle Products Innovation Institute, 2010) which provides products and manufacturers with a tangible validation of their ongoing commitment to sustainability. However, of the 500 certified entities only around 10 percent would traditionally be considered products.
Many of the certified things are building materials, paints, clothing and detergents, so transforming industrial manufacturing processes, rather than consumer goods.

2.4.6 The Circular Economy

The Circular Economy (CE) has many similarities to the approaches considered above and is being seen as a key way for business and government to maintain economic growth and innovation while improving their sustainability (McAlone and Pigosso, 2017). CE allows the economy to continuously develop while preserving Natural Capital, optimising resources by improving yields and managing finite stocks (Moreno et al., 2016). The Ellen MacArthur Foundation (2015a) define CE as “an economy that provides multiple value-creation mechanisms which are decoupled from the consumption of finite resources”. This definition rests on three principles:

- **Preserve and enhance natural capital** by controlling finite stocks and balancing renewable resource flows – for example, replacing fossil fuels with renewable energy or returning nutrients to ecosystems.

- **Optimise resource yields** by circulating products, components, and materials in use at the highest utility at all times in both technical and biological cycles – for example, sharing or looping products and extending product lifetimes.

- **Foster system effectiveness** by revealing and designing out negative externalities, such as water, air, soil, and noise pollution; climate change; toxins; congestion; and negative health effects related to resource use.

Figure 2.6, below, outlines the Circular Economy diagrammatically; this representation was adapted from the Cradle to Cradle Design Protocol (MBDC, 2005). It is clear that in many ways CE thinking is no different from many other approaches (Moreno et al., 2016).
However, CE has gained more traction amongst business and government (McAloone and Pigosso, 2017) than many of the previous approaches. Enterprises have already adopted a CE approach and reported financial and other benefits like improved customer loyalty (De los Rios and Charnley, 2017). The take-up is partly due to the resources that are available and the way in which the Ellen MacArthur Foundation has approached the issue, much more as a lobbying organisation than a research institute. IDEO the international design and consulting firm has created The Circular Design Guide in collaboration with the Ellen MacArthur Foundation (IDEO, 2016). There is also European Union action plan for the Circular Economy (European Commission, 2015) much like there were directives on Energy-using Products (EuP) and Waste Electrical and Electronic Equipment (WEEE) in the past, see Appendix D. Although it may seem that the same issues have been struggled with for twenty years, governments, businesses, NGOs and wider society have moved the debate forward (McAloone and Pigosso, 2017) and the Circular Economy approach seems to be having actual positive impacts on the ground.
2.5 EcoDesign Practice

There has been an increase in the number of case studies of EcoDesign practice (Lofthouse, 2001). Many case studies presented in literature remain only concept projects that have not been put into practice but increasingly case studies exist of designs now on the market where EcoDesign has been a consideration to some degree. These are beginning to inspire designers and businesses that improved environmental performance need not come at the cost of economic viability. Companies like Electrolux, Herman Miller and Miele have all demonstrated that designers can consider environmental issues while still creating competitive products (Bhamra and Lofthouse, 2007). However, many of the product examples that can be seen in places such as Fuad-Luke (2002) are not really EcoDesign. The products tackle single aspects like Design for Disassembly, Design for Recycling and the use of recycled materials. Often products are made from ‘natural’ materials or obviously reused items, and some just have an organic aesthetic. Although it has been demonstrated that designers can influence the environmental performance of the products they create, this has not become widespread practice (Stevenson and Lofthouse, 2013). One of the main reasons cited for this is that designers do not have the right mechanisms to support EcoDesign at the early development stages of the design process (Lofthouse, 2003).

2.5.1 Design Process

The design process is notoriously difficult to pin down. This is partly due to the word design itself having so many meanings, and also because designers can work in very individual ways. However, it is useful to have a model to describe the steps in a specific project or organisation, not only because without a predefined strategy it is almost impossible to judge the progress or outcomes of a project objectively, but also because in the absence of a model it is tough to repeat or improve procedures. Appendix A shows a version of the design process integrated with the wider context of a design consultancy (Stevenson, 2013, p.129).

2.5.1.1 Emergence of Design Methodology

The origins of design methodology have been closely linked with the Cold War and the large-scale ventures prompted by it (Bayazit, 2004). Even though there had been earlier process models developed to deal with the complexity of creating battleships and
other military projects, by the late 1950s it was felt that martial methods needed external input in order to compete with the Soviet Union, and in particular catch up in the space race. During the 1960s government departments, particularly in the United States, started investing in creative research helping to initiate the ‘design methods movement’ (Bayazit, 2004). At a similar time, business and engineering process models were also being established, reflecting the increasing complexity of organisations and their activities (Dubberly, 2004). This complicated backdrop was another important factor in the establishment of design methodology as a discipline in its own right.

2.5.1.2 Development of the Design Process

Although process models were being developed in multiple disciplines, design has distinct characteristics that differentiate it from scientific, artistic and other fields. The main feature that separates scientific strategies from the design approach is their focus on different aspects of a problem. Scientists generally approach problems by trying to derive relationships and understand fundamental rules that can be applied to produce specific repeatable outcomes. Designers focus on solutions and suggest multiple concepts that meet the attributes of a problem, picking which of them they consider to best fit the brief (Coyne et al., 1990; Joyce et al., 1998; Cross, 2007). There are ways in which a designer could be seen an applied artist, like a sculptor shaping objects, and although their internal creative processes are not necessarily distinct (Cooper and Press, 1995), an important differentiation is that the “act of designing is the formulation of a prescription or model for a finished work in advancement of its embodiment” (Archer, 1965). In other words, a creative process has no predefined outcome, an artist starts with an idea and has no clear description of the result until the work is finished. A designer starts with a brief or specification and works towards a particular goal, the process is complete when the objective is met. So, there must be originality, not just calculation, for an activity to be called design, but it is important to find a balance between structure and flexibility for the process to be successful (Cross et al., 1981). The complexities of modern design problems are widely accepted as an important driver in the establishment of design process models (Alexander, 1964; Archer, 1965; Cross, 1984; Jones, 1992; Norman, 2002; Sato, 2009). In addition to products becoming more complicated, understanding the needs of consumers has become increasingly important (Bull, 1998). Although designers like Henry Dreyfuss (1955) utilised anthropometry, since that time the needs of users have been explored in more
and more sophisticated ways. This requires design teams with a variety of skills, the members of these groups may all work for one large organisation (Poggenpohl, 2009) or be brought together for specific projects in small companies (Best, 2006). However, there are other wider considerations, in particular, the need to systematise creativity. Designers, and particularly those in consultancies are expected to design a wide range of products, rather than repeating techniques learnt during an apprenticeship. Without creating a model, or some way of judging the progress or performance of a design project there is no way to repeat or improve the process (Dubberly, 2004). With this need to tackle a variety of briefs, coordinate diverse groups and meet deadlines a simple craft-based model cannot be followed (Lawson, 2006). This could perhaps be summed up by the ‘4 Cs’ of design: Creativity, Complexity, Compromise and Choice (Walsh et al., 1992).

2.5.1.3 Multiple Design Processes

There is no one infallibly correct design process; design solutions cannot be found just by following logic alone (Lawson, 2006). It could be argued that there are as many models of the design process as there are designers because each individual has their own ways of doing things, Dubberly (2004) records over a hundred descriptions of different design processes. However, this does not mean that considering design methodology is not useful despite the many attempts to draw these models (Cross, 2008). It is important to understand the purpose of creating models. Early models, like those of Morris Asimow (1962) were created to describe and direct the progress of engineering design projects. Instead of expressing the thought processes of designers, design was considered at a strategic, rather than individual level. This macro view of design lends itself to a more linear analysis of design activities, though even at this stage feedback loops were included because it was clear that ideas would be evaluated and modified throughout the design process. It was not long before academics were developing models that also specifically considered the creative side of design. At the forefront of these thinkers was L. Bruce Archer (1965), who had started his career practising as a mechanical engineer, before teaching in art and design institutions. He promoted a ‘rational approach’ to design, realising that it was important for designers to have more than just craft skills, but that “if the solution to a problem arises automatically and inevitably from the interaction of the data, then the problem is not, by definition, a design problem.” (Archer, 1965) His model of the design process,
shown in Figure 2.7, began to include the iterations that actual designers make. These feedback loops are inevitable in an outcome-based process where multiple solutions are considered then accepted, rejected or modified.

Figure 2.7. Basic Design Procedure (Archer, 1965, p.6)

Having an iterative process is very important for designers. A purely linear process implies that all the decisions at any one step have been made and finalised, and there is no way to modify these judgements. This is fine when following a scientific principle or law, but not when creating new products (Hickling, 1974). Looking for a perfect solution before moving through the process is not an efficient way to create, especially since a single solution probably does not even exist. Drawing concepts and creating prototypes are an important part of the design process.

Figure 2.8. Linear Iterative Process (Hickling, 1982, p.277)
Feedback loops represent the incremental decision-making that is an essential component of all design (Austin et al., 2001). Figure 2.8, above, shows a generalised form of this linear iterative process. Many models use this combination of a sequential process with feedback loops (Dubberly, 2004). It allows individual stages in the process to be designated and scheduled so that design teams can work to the same time-frame while allowing for the evaluation and modification of decisions. The model shown in Figure 2.9, created by Mesarovic (1964), has a central linear structure. It begins with the definition of a need, or brief, and as time progress it leads to a concrete solution or product but is enhanced by a spiral representing the constant Analysis-Synthesis-Evaluation-Communication loops that are made in the real world.

Figure 2.9. Spiral Model of the Design Process (Watts, 1966, p.85)
Later Pugh (1990), see Figure 2.10, developed a more complex ‘Total Design’ model, to express not only the linear time progression and iterations (though not as a helix) but also all the other elements that need to be considered during a design project.

Figure 2.10. Total Design Activity Model (Pugh, 1990, p.11)
As different thinkers developed models of the design process, these models became increasingly sophisticated, and also tended to become more descriptive than prescriptive (Tomiyama, 2009). This was in large part because academics attempted to mimic more closely the individual activities and thought processes of designers. There was a progression from abstract overarching concepts to the specifics of individual design activities (Clarkson and Eckert, 2005). Instead of trying to impose a process from above, to improve the productivity of designers, these models were created by observing designers and what they actually do. However, there is a downside to these elaborate cyclic iterative design processes. If the models try to replicate the real world too closely, they become overly complicated to use or understand and invalidate the reason for creating a model in the first place (Hickling, 1982).

Contemporary models have become more simple in appearance, giving only general headings like Observation, Brainstorming, Prototyping, Implementation (Fry, 2004). This is not because design has become less complex, it is largely due to the realisation that projects have become so complicated and so varied that they could not be expressed in one diagram. Rather than having a single process, there is a standardised model that is useful for understanding and improving procedures and gives a starting point when initiating a project. A customised model is then created to set out the necessary steps in the creation of a specific product (Best, 2006). This could be seen as a modular way of conducting a project. There is a central core model, which has different blocks plugged in depending on the project. These blocks could require specific experts, or tools that are used to inform and inspire the central design team.

Although current models do not generally show complex collections of lines and loops, like those in Figure 2.8, there is still an attempt to express whether designers should be creating choices or making decisions, if their thinking should be convergent or divergent (Brown, 2009). So at various points in the process there is divergence to create a number of alternatives, and then convergence as these alternatives are evaluated, and the most promising concept or course of action is selected (Banathy, 1996). Both of these phases are needed, not only to create ideas but also take them to a final solution. There are several models that include this divergent-convergent thinking (Banathy, 1996; Design Council, 2007b; Cross, 2008; Brown, 2009), and one of the simplest of these is shown in Figure 2.11.
The Design Council (2007b) model follows Discover – Define – Develop - Deliver, but there are a variety of models that use a similar set of basic steps. The specific words in these models are different, but many of them are synonyms, or there are clear crossovers in each set of concepts.


Discover - Identify – Validate – Articulate (Dubberly, 2004)

Inspiration – Ideation – Implementation (Brown, 2007)

Discover - Define - Design - Develop – Deploy (Dubberly, 2009)

A modification of the Double Diamond Model is shown in Figure 2.12, reflecting that there must be an overall convergence in order to settle on a final design. Cross (2008) notes that “normally, the overall aim of a design strategy will be to converge on a final, evaluated and detailed design proposal, but within the process of reaching that final design there will be times when it will be appropriate and necessary to diverge, to widen the search or to seek new ideas and starting points. The overall process is therefore convergent, but it will contain periods of deliberate divergence.”
The y-axis of Figure 2.12 shows design alternatives, and it is clear that the number of options available are greater the closer a designer is to the beginning of the design process. The importance of the choice that this offers, in the context of EcoDesign, is discussed further in Section 2.5.2. This section has tried to give an overview of the design process and the variety of models that exist. Given the large number of models, it does not attempt to be a comprehensive list but tries to give some of the main archetypes. There are many different ways of looking at the design process, and the specifics of any problem-solving process are inevitably dependent on the individual. However, at a strategic level, universal traits can be seen to link all design process models.

2.5.2 EcoDesign Design Process

The design process plays a significant role when considering EcoDesign because the majority of economic and ecological costs of a product are locked in at the design stage.
(Graedel and Allenby, 2010). However, it is also important to think about resources at every stage of the design process, the reason for this can be most clearly seen in Figure 2.12. The number of design choices that can be made are reduced as the design alternatives converge toward the end of the process, which means comparatively little can be done about resource efficiency if it is not considered until the design stage is close to completion (Bhamra, 2004). The extent to which designers can influence the final product is very dependent on the stage of the product development process they are involved with. Product designers can have two different roles in the design process; they can either have a strategic or operational function and sometimes both (Bakker, 1995). In the operational role, they are responsible for specifying materials, processes, manufacture, in fact, the majority of resources used in the production of goods (Dewberry and Goggin, 1996). Appendix B shows the key factors in embedding sustainability into the new product development (Goffin, 2012, p.114).

Figure 2.13. EcoDesign Process (Tischner and Dietz, 2000, p.39)
Figure 2.13, above, shows an operational EcoDesign process in relation to a general linear iterative design process. The impact of the operational designer begins with the ‘idea generation and selecting ideas’ phase; this could also be called the preliminary design or conceptual design section of the design process. The operational EcoDesign process shown on the left indicates the areas that should be considered through the rest of the life cycle of the product. This includes considerations such as: using minimal materials; minimising the number of components; using recycled or reused materials; minimising energy used in production and design for durability. However, the further through the process the less that can be done. For example, if resource efficiency is not considered until the ‘final proposal/prototype’ it is hard to do more than select recycled materials. Stepping back to the detailed design phase, it is possible to reduce the number of parts, make the product easier to dismantle and recycle or reuse it. Earlier at the ‘idea generation’ or concept part of the process, much more fundamental changes can be made, such as reducing the energy consumption of the product during its use. Although it is clear that many improvements can be made by designers at an operational level if they are involved at the strategic stage of a project they can have an even greater impact. Brezet (1997) explains that it is only with this strategic input on product function, and innovation in system thinking, that a truly resource efficient process can be achieved. The wedge shown in Figure 2.14 corresponds to the convergent shape demonstrated in Figure 2.12, they both represent that the influence designers can have diminishes as the product development process progresses, and in turn that the greatest impact can be made if environmental considerations are made right at the beginning with the definition of a need, or brief (Sherwin and Bhamra, 1999). It is at a strategic level that decisions are made about the purpose of a product, the function it will fulfil, and the way consumers will interact with it (Bakker, 1995).

![Figure 2.14. Model of Strategic EcoDesign Process (Bhamra et al., 2001, p.4)]
It is important to remember that with the increased influence designers can have, working at a strategic level, they also carry greater responsibility. Figure 2.15 shows the main six elements that determine the ability of a consultant designer to engage in EcoDesign:

- Motivation of Consultant to Engage in EcoDesign
- Ability of Consultant to Identify How to Address EcoDesign
- Capabilities of Consultant to Engage in EcoDesign
- Level of Influence of Consultant has to Engage in EcoDesign
- Opportunities Available for Consultant to Engage in EcoDesign
- Implementation of Design Created by the Consultant

Figure 2.15: Factors Determining the Ability of Design Consultants to Address Needs of Society (Stevenson et al., 2011b, p.182)

It also shows the much wider underlying issues that affect these six determining factors. Designers connect industry with the consumer, they “make the link between products and people” (Dewberry and Goggin, 1996) and “can directly influence the decisions people make about what they buy and why” (Bhamra and Lofthouse, 2007). This is a privileged position, and can just as easily be used to create irresponsible consumerism as it can to improve resource efficiency.
2.5.3 Barriers and Drivers of EcoDesign

A clear description of some of the barriers and drivers of EcoDesign were brought together by Brezet and van Hemel (1997). However, research by the UK Design Council revealed that designers still do not consider that their ability to provide environmental advice is important to clients, with only 16 percent of design consultancies believing it is an important factor for winning work (Design Council, 2010). A wide-ranging study was made of the existing literature that examines businesses and their attitudes towards the environment. This revealed that companies were aware of more than thirty different stimuli or obstacles to implementing ecological thinking. These were compiled into a spreadsheet, see Appendix C, and then plotted on two doughnut charts. The charts shown in Figure 2.16 and Figure 2.17 display the relative number of times a particular barrier or driver was observed in the literature but was not intended to provide a quantitative result. However, they do provide a visual digest of over twenty independent papers, any overlap in data was intentionally avoided where possible.

Figure 2.16: Barriers to EcoDesign

The most prevalent of these are issues such as: lack of knowledge or skills (Chick and Micklethwaite, 2002; de Eyto et al., 2008; EcoDesign Circle, 2017; Gerstenfeld and Roberts, 2000; Hutchinson and Hutchinson, 1995; Lofthouse, 2001; Meinel and Höferl, 2017; Merritt, 1998; O’Rafferty et al., 2008; Rizos et al., 2016; Rossi et al., 2016; Scheer and Rubik, 2006; Smith et al., 2000; Valero-Gil et al., 2017; van Hemel and Cramer,
2002); lack of time and the associated costs (Chick and Micklethwaite, 2002; EcoDesign Circle, 2017; Gerstenfeld and Roberts, 2000; Hutchinson and Hutchinson, 1995; Lofthouse, 2001; Meinel and Höferl, 2017; O’Rafferty et al., 2008; Rizos et al., 2016; Rossi et al., 2016; Scheer and Rubik, 2006; Smith et al., 2000; Valero-Gil et al., 2017; van Hemel and Cramer, 2002). However, matters such as company environmental ethos (Baylis et al., 1998; Bhamra, 2004; Dewberry, 1996; Govindan et al., 2015; Green et al., 1994; Merritt, 1998; Prendeville et al., 2014; Rizos et al., 2016; van Hemel and Cramer, 2002), government policy (Gerstenfeld and Roberts, 2000; O’Rafferty et al., 2008; Prendeville et al., 2014; Rizos et al., 2016; Rossi et al., 2016; Scheer and Rubik, 2006; Smith et al., 2000; van Hemel and Cramer, 2002), market demand (EcoDesign Circle, 2017; Green et al., 1994; Merritt, 1998; Rossi et al., 2016; Scheer and Rubik, 2006; van Hemel and Cramer, 2002) and investment opportunities (Chick and Micklethwaite, 2002; EcoDesign Circle, 2017; Meinel and Höferl, 2017; Smith et al., 2000) have also been established as significant factors in the practice of EcoDesign.

Figure 2.17: Drivers of EcoDesign

The papers used to create the barriers and drivers diagrams spanned twenty years, with a number of them being from 2017. However, virtually all of the categories could have been seen in the Dutch Promise Manual (Brezet and van Hemel, 1997). This is perhaps an endorsement of the thoroughness of that initial work. Table 2.3 presents the results from a similar review conducted by Johansson (2002) but with the results presented in a more detailed and nuanced way. The information in the table is complimentary as it
is more aligned with the design process and offers suggestions on how this might be modified to better support EcoDesign. One aspect that is included in the table but not referred to in Figure 2.17 is the importance of the design community and the sharing of good examples of EcoDesign (Bakker, 1995; Lofthouse, 2017; McAloone, 1998).

Table 2.3: Success Factors for Integration of EcoDesign in Product Development (Johansson, 2002, p.105)

<table>
<thead>
<tr>
<th>Area of Concern</th>
<th>Success factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>Commitment and support are provided</td>
</tr>
<tr>
<td></td>
<td>Clear environmental goals are established</td>
</tr>
<tr>
<td></td>
<td>The environmental considerations are addressed as business issues</td>
</tr>
<tr>
<td></td>
<td>Not only the operational dimension of ecodesign should be considered, but also the strategic dimension</td>
</tr>
<tr>
<td></td>
<td>Environmental issues are included when establishing a company’s technology strategy</td>
</tr>
<tr>
<td>Customer relationships</td>
<td>A strong customer focus is adopted</td>
</tr>
<tr>
<td></td>
<td>Companies train their customers in environmental issues</td>
</tr>
<tr>
<td>Supplier relationships</td>
<td>Close supplier relationships are established</td>
</tr>
<tr>
<td>Development process</td>
<td>Environmental issues are considered at the very beginning of the product development process</td>
</tr>
<tr>
<td></td>
<td>Environmental issues are integrated into the conventional product development process</td>
</tr>
<tr>
<td></td>
<td>Environmental checkpoints, reviews and milestone questions are introduced into product development</td>
</tr>
<tr>
<td></td>
<td>Company-specific environmental design principles, rules and standards are used</td>
</tr>
<tr>
<td></td>
<td>Ecodesign is performed in cross-functional teams</td>
</tr>
<tr>
<td></td>
<td>Ecodesign support tools are used</td>
</tr>
<tr>
<td>Competence</td>
<td>Education and training are provided to the product development personnel</td>
</tr>
<tr>
<td></td>
<td>An environmental specialist supports the development activities</td>
</tr>
<tr>
<td></td>
<td>Examples of good design solutions are utilised</td>
</tr>
<tr>
<td>Motivation</td>
<td>A new mindset emphasising the importance of the environmental considerations is established</td>
</tr>
<tr>
<td></td>
<td>An environmental champion exists</td>
</tr>
<tr>
<td></td>
<td>Individuals are encouraged to take an active part in the integration of ecodesign</td>
</tr>
</tbody>
</table>
2.6 EcoDesign Methods and Tools

EcoDesign methods have been developed since the early 1990s (Ghorabi et al., 2011), and there are nearly as many EcoDesign tools as there are models of the design process. The G.EN.ESI (2012) project notes that there are at least 150 EcoDesign tools, but that their use is still very limited (Lindahl, 2005). Many of the tools do not fully integrate with the product design process and are not applied until the engineering stage of the process (Behrisch et al., 2011). As was shown in Figure 2.1, this can be outside of the control of SDCs as these decisions are made by the client and their in-house teams. Figure 2.18 shows some of the main EcoDesign methods and tools, and how they relate to the design process. This is not a definitive list, but a comprehensive table, including weaknesses of the tools, can be found in Rossi et al. (2016, p.367-368).

Figure 2.18: EcoDesign Methods and Tools (Bovea and Pérez-Belis, 2012, p.62)
Table 2.4 shows these EcoDesign tools can be placed into six overall categories, and these are used in the following sections (McAloone and Pigosso, 2018).

Table 2.4: Categories of Tools for Environmental Product Development (Baumann et al., 2002, p.415)

<table>
<thead>
<tr>
<th>Frameworks</th>
<th>Analytical Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checklists and Guidelines</td>
<td>Software and Expert Systems</td>
</tr>
<tr>
<td>Rating and Ranking Tools</td>
<td>Organising Tools</td>
</tr>
</tbody>
</table>

2.6.1 Frameworks

Frameworks describe general ideas that guide thinking during the design process (Baumann et al., 2002). The frameworks have recognisable names such as Design for Environment (DfE) focuses on a single specific design issue at a particular stage in the design process (Charter and Tischner, 2001). DfE can be used as a more general term for the following definitions. Design for Disassembly (DfD) is a technique for producing products that are easy to disassemble so that they can be efficiently recycled or reused (White et al., 2007). Design for Recycling (DfR) is similar to Design for Disassembly, but should also consider using fewer materials and enable easier sorting of parts (Lewis and Gertsakis, 2001). Design for Serviceability (DfS) makes the product easy to service and/or repair, so its useful life can be extended and reduced the need for more products (White et al., 2007). There is a wide range of nomenclature, and the terms are often interchanged despite their specific meanings. Other frames works include Design for Re-use/Upcycling; Design for Behaviour Change/Awareness; Design with Low Impact Materials; Design for Efficiency/Reduce; Design for Reliability and Robustness; Design for Multi-Functionality/Upgradability; Design for Low Impact During Use. Sustainability has become part of general parlance, so the term Sustainable Design is often used when one of the other terms would be more accurate. It is important to clarify what any individual means when they use one of these terms.
2.6.2 Checklists and Guidelines

EcoDesign checklists are basic tools, listing important factors that need to be considered in the design process, such as “Has the number of different materials been limited where practicable?” and “Have surface coatings been avoided?” (Clark et al., 2002). However, these tables or bullet points do little to inspire the designer. They can be useful to reassure designers that they have considered all aspect of their design and when checking compliance with environmental laws. Guidelines are similar to checklists but have much more scope for the use of diagrams, images and other communication methods rather than just text. Guidelines can teach and inspire designers, as well as reminding them of the important EcoDesign issues that need to be considered during the development process (Lofthouse, 2001).

2.6.3 Rating and Ranking Tools

Qualitative Assessment tools are a quick and easy way to gauge products. They work by selecting several criteria such as material use, energy use and ease of recycling. Each criterion is then rated from good to bad or on a numbered scale. With tools like Eco-compass (Fussler and James, 1996), LiDS (Life-cycle Design Strategy) wheel (van Hemel, 1998), Ecodesign Web (Lofthouse and Bhamra, 2003) and SPeAR (Sustainable Project Appraisal Routine) model (Arup, 2007) these values are plotted on a graph or diagram to compare their shapes. Alternatively, the criteria are just rated as better or worse when compared to another product. The main drawback with these tools is the simplicity of information they supply. They are only really useful when comparing two similar products or concepts and neglect a large part of the design process.

2.6.4 Analytical Tools

Life Cycle Assessment (LCA) is a scientific method of assessing the environmental impact of a product. It covers the whole product life-span from the extraction of materials to its ultimate disposal. There are many existing LCA tools such as GaBi 4 (PE International, 2008), SimaPro (PRé Consultants, 2015), (Sustainable Minds, 2008) and openLCA (GreenDelta, 2006). CES Eco Selector (Granta Design, 2008) is slightly different because it integrates an LCA tool with material selection technique developed by Prof. Michael Ashby (2005).
It is not generally recommended for designers to carry out an LCA because they are time-consuming to complete (Bhamra and Lofthouse, 2007). However, there are certain situations where a Life Cycle Assessment can be useful. In larger companies, or where similar products are being repeatedly produced LCAs can serve as a useful product comparator. This repetition means that time is not such a factor and areas of doubt such as the source of materials, processing and final disposal cancel each other out.

Embody energy, in this context, is a measure of the energy required to manufacture and supply a product. It is a good indicator for systems that are dominated by energy use (Lewis and Gertsakis, 2001). However, it does not take account of the environmental impact of using certain materials. In particular, when it comes to natural materials like wood there is no account taken of CO₂ levels, biodiversity and the impact deforestation has on the land.

2.6.5 Software and Expert Systems

The aim of the software and expert systems is to process similar amounts of environmental information to the LCA tools discussed in Section 2.6.4, but also be quick and easy to use. Expert systems are designed to avoid the need for large amounts of data collection and environmental expertise. Two examples of this are the LEADS-II (Rombouts, 1998) system which enables product developers to assess the potential of different DfE options, and APES (Matzke et al., 1998) which was an environmental tool manager at Apple Inc. This category also includes Simplified LCA tools like EarthSmart (Global, 2012), Ecotoollkit (2011) and Greenfly (RMIT Centre for Design, 2008) which are essentially a well presented, easy to use online LCA. There are many more of these tools, but they are the outcomes of research projects, so have ceased being updated or supported.

There are also tools that integrate with CAD such as SolidWorks Sustainability (Dassault Systèmes, 2017) which evaluate the environmental consequences of choices made in creating a product. The CAD model contains considerable amounts of information about a design. If an assembly includes all the relevant parts, defined with appropriate material properties, with relatively few steps SolidWorks Sustainability can predict the impact on air, carbon, energy and water embodied by the design.
2.6.6 Organising Tools

Organising tools fall into two main categories: organising EcoDesign workshops for awareness raising or for discussing tools and strategies; and for giving direction on how to organise tasks for a company and their stakeholders. In order to identify key issues for the companies, a review is carried out by the product development team. This could include talking with environmental experts within the company and interviewing potential customers about environmental issues. EcoDesign workshops can take a number of forms but is a good place to use tools, such as play rethink (Rethink Games, 2007), Energy Trumps (The Agency of Design, 2011), and Social Issues Cards (Lofthouse, 2014). They contain information about sustainability, but their main aim is to generate new ways of thinking. These games are more practical for teaching sustainable design than practising it. This is because they do not necessarily help with a particular project, and can take a long time to complete.

2.6.7 Resources

There are many online EcoDesign Resources such as BioThinking (Datschefski, 2009), indes.net (Independent Designers Network, 2008), Productlife (Sheffield Hallam University, 2008), [re]design (Redesigndesing, 2009) and seeba (Centre for Sustainable Design, 2008). These resources include useful information such as articles, definitions, discussion forums, material information and links to other websites. However, they have several limitations. The interfaces, often those designed by academics, do not engage the user or are difficult to use. The breadth of information is often too narrow and out of date, or so broad it is too time-consuming to process (Charter and Tischner, 2001). Information/Inspiration (Lofthouse, 2008) stands apart from the other online resources. The needs of designers have clearly been investigated, and the level of detail contained in the site make it a valuable source of information. Many of the other resources are just collections of links and insufficiently utilised forums.

There are also some off-line publications such as Ecodesign Navigator (Simon et al., 1998) and Okala: Learning Ecological Design (White et al., 2007). The content of these books has been given greater consideration, making them more useful. Unfortunately, as with all paper-based sources, their content becomes outdated very quickly.
2.6.8 Legislation, Directives and Standards

It has not been possible for the governments of the world to agree on any global environmental laws, but they have made some declarations of intent in the form of Protocols and Directives. Many, though not all members of the international community are signatories to relevant treaties such as The Montreal Protocol (1987) and The Kyoto Protocol (1998). At the end of the 2012 United Nations Framework Convention on Climate Change (UNFCCC), an agreement was reached to extend the Kyoto Protocol to 2020. In 2015 at the 21st Conference of the Parties of the UNFCCC in Paris, the Paris Agreement (UNFCCC, 2015) was negotiated to succeed the Kyoto Protocol. In 2017, the 45th President of the United States announced his intention to withdraw the United States from the agreement. To have the greatest impact laws need to be created more locally, usually at the national level. However, the European Union (EU) has also been able to agree on regulations that cover their many countries. There is a range of producer responsibility literature into force from the European Commission that means more than ever before companies are required to consider some aspects of EcoDesign. Directives passed into European law are often not expected to be transposed into national law for several years, and often there are different and sliding timescale for the separate Member States. For example, the Waste Batteries and Accumulators Regulations come into force in the UK on 5 May 2009 but were passed by the European Parliament in September 2006. A full list of EU legislation, directives and standards can be seen in Appendix D.

2.7 EcoDesign, Emotion and Rational Choice

There are many social-psychological models that have been proposed to understand and predict behaviour (Jackson, 2005b). The rational choice model, shown in Table 2.5, is akin to the neoclassical economic theory presented in Table 2.1 and is one that also guides economic and political policy.

Table 2.5: The Three Assumptions of the Rational Choice Model (Jackson, 2005b, p.vii)

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Assumption</td>
<td>Individual self-interest is the appropriate framework for understanding human behaviour.</td>
</tr>
<tr>
<td>Second Assumption</td>
<td>‘Rational’ behaviour is the result of processes of cognitive deliberation.</td>
</tr>
<tr>
<td>Third Assumption</td>
<td>Consumer preferences are exogenous to the model – that is to say they are taken as given without further elaboration as to their origins or antecedents.</td>
</tr>
</tbody>
</table>
However, the rational choice model has been widely criticised (Mustaquim and Nyström, 2014) because it is well known that people do not necessarily make decisions based on cognitive deliberation, often taking a number of mental short-cuts when deciding what to do (Kahneman and Krueger, 2006). One of the more complete models of behaviour is the Theory of Interpersonal Behaviour (TIB) proposed by Triandis (1977) and as depicted in Figure 2.19.

![Figure 2.19: Theory of Interpersonal Behaviour (Jackson, 2005b, p.94)](image)

TIB states that behaviour is determined by what that person perceives to be appropriate in that particular situation, and this is influenced by several factors including emotions, self-perception, social norms and past behaviour (Sacchi et al., 2016). When considering emotions and how it influences the response to EcoDesign, it is important to be precise in the use of the word ‘emotions’. Only in general parlance is it synonymous with words such as feeling, sentiment or mood (Desmet, 2002; Scherer, 2000). There are a wide variety of phenomena that have the word emotion applied to them, but these ‘affective states’ (Scherer, 2000) do have distinct meanings. Emotions have a comparatively short lifespan and are typically brought about by identifiable internal or external stimuli. Examples of this are that people can be angry at someone; afraid of something; or proud of themselves (Frijda, 2009). Though the
precise definition and nature of emotion is debated by psychologists, there is agreement on its brief but episodic nature (Desmet, 2002; Frijda, 2009; Scherer, 2005; Jordan, 2000). Mood differs from emotion due to its comparatively long-term duration, and because it is much harder to pinpoint a specific cause. Moods often stem from a variety of origins and may not even be perceivable by the person experiencing them (Desmet, 2002). Sentiments or attitudes like emotions are directed at people or things but can persist for a much longer period. Though there are similarities, Desmet (2002) explains that there is a difference between being afraid of dogs (attitude) and being frightened by a dog (emotion). Personality or emotional traits are long-term characteristics, and this longevity differentiates them from moods. Like moods, they are not directed by a specific cause or object (Scherer, 2005). Table 2.6 gives more examples of these affective states.

Table 2.6: Delimitation of Different Affective States (Scherer, 2000, p.140)

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion</td>
<td>Relatively brief episode of synchronized responses by all or most organismic subsystems to the evaluation of an external or internal event as being of major significance (e.g., anger, sadness, joy, fear, shame, pride, elation, desperation).</td>
</tr>
<tr>
<td>Mood</td>
<td>Diffuse affect state, most pronounced as a change in subjective feeling, of low intensity but relatively long duration, often without apparent cause (e.g., cheerful, gloomy, irritable, listless, depressed, buoyant).</td>
</tr>
<tr>
<td>Attitudes</td>
<td>Relatively enduring, affectively coloured beliefs, preferences, and predispositions toward objects or persons (e.g. liking, loving, hating, valuing, desiring).</td>
</tr>
<tr>
<td>Personality Traits</td>
<td>Emotionally laden, stable personality dispositions and behaviour tendencies, typical for a person (e.g. nervous, anxious, reckless, morose, hostile, envious, jealous).</td>
</tr>
</tbody>
</table>

All of these affective states may influence people, but given their individual definitions, emotion has a particular significance in the context of design and designers (Desmet et al., 2008). According to Triandis (1977) behaviour in any given situation is, partly
controlled by intention, partly by habitual responses, and partly by the situational constraints and conditions. This means that intentions are influenced by social, normative and affective factors as well as by rational deliberations. In this model, people are neither fully deliberative nor fully automatic. Beliefs influence behaviours, but the consequences of these are moderated by both emotional drivers and cognitive boundaries (Jackson, 2005b). While the rational choice model and TIB models describe the reasons for a particular behaviour; they do not focus on how these behaviours can be changed. The change in behaviour is necessary as a shift is required for more EcoDesign products to be designed and sold. The cognitive dissonance theory (CDT) Festinger (1957) considers when people hold two conflicting perceptions (cognitions) in relation to their behaviour, the dissonance this creates, and the mechanisms through which it can be eased (Lavergne and Pelletier, 2015). Dissonance causes psychological discomfort, and CDT proffers that people are motivated to reduce it in two main ways, either changing their behaviour or altering their attitudes through cognitive restructuring (Mustaquim and Nyström, 2014). The model shown in Figure 2.20 describes this process. In the context of environmental attitudes and actions, behaviour modification could be taking steps to counter-balance the impact of previous negative environmental actions, and cognitive restructuring could be changing attitudes to trivialise pro-environmental opinions (Lavergne and Pelletier, 2015).

![Figure 2.20: Cognitive Dissonance Theory Model (Adapted from Lavergne and Pelletier, 2015, p.144)](image-url)
Over a hundred different biases have been identified in the sixty years since Festinger first proposed CDT. The biases can exist in all aspects of life and are used to simplify the world and create cognitive ease. Table 2.6 describes some of the biases that directly affect environmental behaviour.

<table>
<thead>
<tr>
<th>Cognitive Bias</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalcy Bias (Han et al., 2017)</td>
<td>People are only likely to take action when they become aware of the harmful consequences of their behaviours and ascribe some responsibility to themselves.</td>
</tr>
<tr>
<td>Selective Perception (Finucane et al., 2000)</td>
<td>If people ‘like’ an activity they tend to judge its risks as low and its benefits high. If people ‘dislike’ an activity they tend to perceive it as high risk and low benefit.</td>
</tr>
<tr>
<td>Purchase Rationalization (Davies and Gutsche, 2016)</td>
<td>A lack of information on an EcoDesign product can be a positive attribute as it allows scope for people to invent self-meaning in ethical products.</td>
</tr>
<tr>
<td>Optimistic Spatial Bias (Gifford et al., 2009; Sacchi et al., 2016)</td>
<td>In general, people believe their local area is less likely to be affected by environmental hazards than elsewhere. This dampens enthusiasm to make changes. Events that are psychologically distant are not perceived as priorities.</td>
</tr>
<tr>
<td>Self-consistency Bias (Lavergne and Pelletier, 2015)</td>
<td>When people are motivated towards pro-environmental behaviour to obtain rewards (or approval), and their actions lead to adverse effects, they minimise their perception of the effect, rather than changing behaviour.</td>
</tr>
<tr>
<td>Illusory Truth Effect (Mustaquim and Nyström, 2014)</td>
<td>Where there is no clear choice, people usually make decisions based on how easy it is to justify the choice to themselves and others.</td>
</tr>
</tbody>
</table>

In addition to these specific biases is the phenomenon of Confirmation Bias sometimes described as ‘believing is seeing’ (Tavris and Aronson, 2015). In essence, this is the tendency to modify perception in order to corroborate existing beliefs. “Once we have
a belief, we see the information that will confirm that belief, and we want to forget anything that is dissonant or discrepant” (Campbell, 2011, p.15). This is why it is very difficult to change beliefs and behaviours, and why strong environmental messages can have a little effect or even produce negative ones (MacDonald and She, 2015). There is potential for confirmation bias to affect the development of a belief or hypothesis at a number of stages in this process (Klayman, 1995):

1) You might start out overconfident in an initial belief. If you do, and are a proper Bayesian otherwise, you will remain overconfident after you receive additional evidence.

2) You may search for evidence in a way that biases the data to favour your hypothesis, for example, by avoiding tests that you think likely to contradict your hypothesis.

3) Your interpretation of the information you receive might be biased in favour of your hypothesis. For example, you may regard hypothesis-confirming data as trustworthy and disconfirming data as dubious.

4) You might revise your confidence in your hypothesis insufficiently given your beliefs about the strength of the data.

5) You may have trouble generating viable new hypotheses even when you do feel like abandoning an old one.

Clearly, it is possible to alter beliefs and behaviours, but this is no mean feat, particularly when attempting widespread change. Some advertising campaigns could claim to have done this, but in the UK perhaps the most successful examples of these are the reduction in rates of smoking (Department of Health, 2011) and increased seatbelt use (ONS, 2011). However, both of these required a large investment from multiple stakeholders, revisions to UK legislation, and still took decades to achieve. This level of intervention is somewhat beyond the remit of this project, but there are more subtle ways to achieve change. Cognitive dissonance can actually be used to create positive changes behaviour (Dickerson et al., 1992). It requires participants to engage in or discuss an activity in a positive way. This can begin at a very low level but establishes a behaviour or attitude. In future situations this can not only be seen as feeding into the
TIB model, see Figure 2.19, but also creates a situation where future actions need to be consistent with the initial step in order to maintain cognitive ease. So, assuming they had a positive experience, designers participating in or engaging with EcoDesign are more likely to do this again in the future. If this can be allowed to develop slowly and consistently over time, it can become normalised. This is much more commonly seen with negative behaviour such as political corruption. People rarely start with large acts of illegal behaviour, they build slowly, and in order to maintain a positive view of themselves, use self-justification to ease any cognitive dissonance they feel about their actions. “How do you get an honest man to lose his ethical compass? You get him to take one step at a time, and self-justification will do the rest” (Tavris and Aronson, 2015, p.37). Behaviour change is a complex topic, which is one of the reasons why global CO₂ emissions (UNEP, 2017) continue to rise despite the long-term growth in concern about human-caused global average temperature increase (Saad, 2017). If it were easy to achieve there would probably be no need for EcoDesign.

The issues described in the context of TIB and CDT are important as they affect designers directly, but also all the other stakeholders in the life cycle of a product, see Figure 2.1. The attitudes, beliefs and behaviours of the designer, client and customer are of particular importance. However, it is also crucial to know how these things might be successfully changed.

2.8 Conclusion

The Literature Review highlighted several important issues that require further investigation. The overall theme was about understanding why there is not a greater prevalence of EcoDesign. There are even more approaches to EcoDesign than demonstrated in Section 2.4 as well as a large number of EcoDesign methods and tools. The obstacle that designers may face is that no one approach is comprehensive or universally accepted. For those that have the time to explore all potential methods and tools, it is likely that they will choose different aspects from various models that suit their view of design. For the less informed, the lack of a clear path makes it difficult to engage in EcoDesign fully.

There were a large number of issues that affect whether SDCs and their designers feel able to participate in projects that address needs of society. As shown in Table 2.8, the literature revealed six main elements, and associated factors, that determine the ability of a consultant designer to engage in EcoDesign.
Table 2.8: Factors Determining the Ability of Designers to Engage in EcoDesign

<table>
<thead>
<tr>
<th><strong>Element</strong></th>
<th><strong>Associated Factors</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation of Designer</td>
<td>Interest and awareness issues in EcoDesign.</td>
</tr>
<tr>
<td></td>
<td>Personal aspirations and objectives.</td>
</tr>
<tr>
<td></td>
<td>Personal ethos, values, ethics or beliefs.</td>
</tr>
<tr>
<td>Capacity of Designer to identify how to address EcoDesign</td>
<td>The level of information available.</td>
</tr>
<tr>
<td></td>
<td>Confidence the designer has in the information.</td>
</tr>
<tr>
<td></td>
<td>Examples of successful EcoDesign.</td>
</tr>
<tr>
<td>Capabilities of Designer</td>
<td>Company environmental ethos.</td>
</tr>
<tr>
<td></td>
<td>Design education and training.</td>
</tr>
<tr>
<td></td>
<td>The talent and aptitude of the designer.</td>
</tr>
<tr>
<td>Level of Influence of Designer</td>
<td>Ability of designer to influence clients.</td>
</tr>
<tr>
<td></td>
<td>Extent of involvement in overall design process.</td>
</tr>
<tr>
<td></td>
<td>Level of experience/profile the designer has.</td>
</tr>
<tr>
<td></td>
<td>Receptiveness of clients to environmental issues.</td>
</tr>
<tr>
<td>Opportunities Available</td>
<td>Demand from the client and customers.</td>
</tr>
<tr>
<td></td>
<td>Type of product/service being designed.</td>
</tr>
<tr>
<td></td>
<td>Project constraints, including Legislation</td>
</tr>
<tr>
<td>Implementation of design created by the Designer</td>
<td>Design selection, including the client brand and marketing strategy.</td>
</tr>
<tr>
<td></td>
<td>Capability of the client to implement design.</td>
</tr>
<tr>
<td></td>
<td>Ability of designer to meet needs of the client.</td>
</tr>
</tbody>
</table>

The table shows both internal and external factors that act as barriers and drivers of EcoDesign. Although not all of these factors are within the direct control of designers, there are opportunities for them to at least influence all of the main elements. Given that designers are able to do this, the question is why there are not more EcoDesign products available to buy? This could be because designers are not prepared to engage in EcoDesign, or the external elements are preventing their designs from coming to
market. The external factors are outside the remit of this research project, so the focus is on how to engage SDCs, and their designers, in EcoDesign.

The first step is motivational, does the designer have an interest and awareness of EcoDesign issues? If there is no interest, and environmental considerations are completely outside the personal ethos and objectives, it is very hard to see any change without additional drivers such as legislation or economic incentives. However, given that almost two-thirds of UK citizens accept climate change is happening and are concerned about its effects (ComRes, 2017) it seems likely that the majority of designers cognizant of the need to design more environmentally benign products, even if they are not actively doing it. Helping designers transition from passive mindfulness to active behaviour change can be achieved using cognitive dissonance and confirmation bias. None of the existing EcoDesign methods or tools take this into consideration; they require motivated users who are prepared to invest time developing the skills to operate them. This is particularly true of the analytical tools such as LCA software. Checklists and guidelines are much easier to use, but for them to be effective, they need to be quite product specific unless the designer knows how to apply them appropriately. This ability to interpret the information correctly requires experience unless the client provides environmental guidelines are part of the brief.

Once motivated the next step is reliant on the capacity of the designer to identify how to address EcoDesign in their projects. This requires knowledge and access to information, including examples of existing EcoDesign products, as well as the confidence to apply these techniques. This may come from design education and training, but this cannot be guaranteed, particularly for those that studied when EcoDesign was not part of their curriculum. Designers, particularly those working in SDCs, are commonly required learn new things as part of the design process. Many of the existing EcoDesign tools have been created with this in mind and are designer-friendly. They are, comparatively, visually engaging and created with an appropriate level of complexity, which makes them easy to learn and apply. Information/Inspiration (Lofthouse, 2001) is one of the few resources that also considers the importance of inspiration and provides examples of successful EcoDesign. However, the concept of Information/Inspiration was originally “dreamt up … in 1998” (Lofthouse, 2008) and technology as well as the way we use it has changed profoundly over that twenty year period. Disappointingly the same cannot be said for the prevalence of EcoDesign products. The growth of the internet and the changes in the way we use it mean that
there is not only access to much more information, but the means of sharing that information has changed dramatically.

Having the appropriate knowledge is key to the ability of SDCs and their designers to engage in EcoDesign, but they also need the confidence to apply this knowledge and persuade clients to let them use it. Clients also need to be reasonably receptive to environmental issues and designer input in order to be influenced. Given this is the case, a number of things affect how self-assured a designer is. An important element is confidence in the information provided, which can be quite low if taken indiscriminately from the internet. This shows the importance of having a trusted source, as well as the evidence of existing products. If a genuine EcoDesign product exists in the marketplace then this is good evidence of the feasibility of the design, as well as the materials and manufacturing processes used. There are many examples of this general principle, one of which is smartphones. Once the iPhone (Apple, 2007) was released this established the technological and economic feasibility of smartphones, and within three years their market share was exceed by their competitors (Gartner, 2017). Providing a trusted source of information is important to inspire designers, help them learn, and give them the confidence to implement EcoDesign principles.

There are some laws, directives and standards that cover the ecological aspect of products. It might be concluded from the information in Section 2.6.8 that the European Union has successfully regulated the production of environmentally friendly goods. However, this is not generally the case; again there is little evidence of a significant number of EcoDesign products on the market.

The section on design process highlighted the large number of theories that have been applied to this subject. This is largely due to the complexity of actual approach that each individual takes. The models inevitably simplify reality in order to create general principles. The resulting process diagram is very dependent on decisions made about which are the most important aspects to include, and who was studied. Dubberly (2004) included academic models, those utilised by design consultancies, and software developers. However, there are few if any universally accepted models of the EcoDesign Process. There are many barriers and drivers of EcoDesign, but underlying all these are the people that commission, design and use products. Understanding how the attitudes and behaviours of these stakeholders might be modified is crucial in finding ways to better integrate EcoDesign principles within SDCs.

Whilst the literature provides a solid basis for developing theories on how to integrate EcoDesign principles with SDCs, much of the information comes from analogous
studies and sources, rather than the specific type of organisation being investigated by this research project. In addition, the existence of EcoDesign methods and tools does not necessarily mean they are being widely used. Hence the need to develop a strategy to conduct primary research in order to answer these questions more fully. The following research questions emerged from the literature review and were used to direct the research methodology and the main study of small design consultancies:

> What type of product design process (PDP) do SDC designers actually use?
> How and when can EcoDesign be integrated into this PDP?
> How do designers currently build skills and knowledge in SDCs?
> Which design tools are currently used, and do any of them consider EcoDesign?
> What knowledge do designers have about Environmental Laws and Standards?
3. RESEARCH METHODOLOGY

This chapter outlines the overarching strategy used to conduct the research. It describes the individual research methods and analysis techniques that were used and demonstrates how the different research phases were brought together to fulfil the aims and objectives established in Chapter 1.

3.1 Introduction

Designing an appropriate research methodology is an essential aspect of conducting successful research (Maxwell, 2005). Having the right research methodology helps to ensure that the project aims are achieved, and the research questions are answered (Phillips and Pugh, 2005). There were seven elements that needed to be considered when the methodology was planned, and selecting the most appropriate category for each of these elements was critical to ensure that the findings were valid:

- Research Philosophy: Interpretivist
- Research Approach: Inductive
- Research Purpose: Exploratory
- Research Type: Qualitative
- Research Strategy: Phenomenological
- Data Collection Techniques: Interviews and Survey Questionnaires
- Data Analysis: Coding and Clustering (Clustering Matrices)

This chapter outlines the research design selected for this study and provides justification for the choices made, regarding the seven elements listed above. It also considers issues such as ensuring of research validity and meeting standards of ethical research and practice. Figure 3.1 shows the overall process for conducting this research, within which the research methodology is contained. It is broken down into three main phases. Phase 1 establishes the research aims, objectives, and through the literature review, the research questions. Phase 2, the study of small design consultancies, describes how the studies were conducted and analysed. Phase 3
focuses on the testing of the prototype resource, collecting the responses from participants and interpreting that data.

Figure 3.1: Overarching Map of Research Process

### 3.2 Research Philosophy and Approach

Whilst a variety of, often subtly, different definitions are suggested by the literature, this thesis uses the descriptions of ontology, epistemology, methodology and method shown in Table 3.1.
Table 3.1: Definitions of Ontology, Epistemology, Methodology and Methods (Easterby-Smith et al., 2012, p.18)

<table>
<thead>
<tr>
<th>Ontology</th>
<th>Philosophical assumptions about the nature of reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemology</td>
<td>A general set of assumptions about ways of inquiring into the nature of the world</td>
</tr>
<tr>
<td>Methodology</td>
<td>A combination of techniques used to inquire into a specific situation</td>
</tr>
<tr>
<td>Methods and Techniques</td>
<td>Individual techniques for data collection, analysis, etc.</td>
</tr>
</tbody>
</table>

In order to develop the most appropriate research strategy, it is important to establish what is to be considered acceptable knowledge, the epistemological position (Bryman, 2008), and the theoretical perspective of the research (Gray, 2009). The methodology, and in turn the method(s) used are dependent upon the standpoint of the research with respect to the nature, sources and limits of knowledge (Jupp, 2006). However, discussion of ontology and epistemology extends back farther than ancient Greek philosophy (Bernard, 2000) and remain contentious today. There is neither a fixed view of the fundamental nature of reality or being, nor the quintessence of knowledge and what constitutes acceptable knowledge (Saunders et al., 2009). In addition to this, while there is some universally accepted terminology, typologies vary with academic discipline or standpoint and also evolve with time (Creswell, 2007; Marshall and Rossman, 2011). However, despite this mutability, it is useful to provide a structure that describes the connections between the different theoretical and methodological standpoints and how they interrelate. The research ‘onion’ shown in Figure 3.2 provides an overview of how the philosophy and approach of an investigation are related and may influence the research strategy and method(s). However, ultimately the research questions may not fit so precisely into the philosophical domains suggested by the ‘onion’ (Saunders et al., 2009).
3.2.1 Research Philosophy

Positivism is the philosophical position that advocates that legitimate knowledge must be founded directly on empirical observation or experience (Schwandt, 2001), following the same assumptions as the scientific method (Bernard, 2000). A positivist approach warrants the use of a highly structured methodology, which can be replicated by others, and produces generalizable conclusions (Saunders et al., 2009). The interpretivist viewpoint advocates the need to understand the variability of humans in their role as social actors (Saunders et al., 2009) and that the laws of science and social reality are different and therefore require their own research assumptions and approach (Gray, 2009). Table 3.2 compares some of these assumptions, purposes and approaches as well as how the role of the researcher differs between the positivist and interpretivist philosophies (Glesne, 1999). This table enables the research questions to be considered within the context of the research philosophy.
Table 3.2: Predispositions of Positivist and Interpretivist Modes of Inquiry (Glesne, 1999, p.6)

<table>
<thead>
<tr>
<th></th>
<th><strong>Positivist Mode</strong></th>
<th><strong>Interpretivist Mode</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assumptions</strong></td>
<td>Social facts have an objective reality</td>
<td>Reality is socially constructed</td>
</tr>
<tr>
<td></td>
<td>Variables can be identified and relationships measured</td>
<td>Variables are complex, interwoven, and difficult to measure</td>
</tr>
<tr>
<td><strong>Research Purposes</strong></td>
<td>Generalizability</td>
<td>Contextualization</td>
</tr>
<tr>
<td></td>
<td>Causal explanations</td>
<td>Understanding</td>
</tr>
<tr>
<td></td>
<td>Prediction</td>
<td>Interpretation</td>
</tr>
<tr>
<td><strong>Research Approach</strong></td>
<td>Begins with hypotheses and theory</td>
<td>May result in hypotheses and theory</td>
</tr>
<tr>
<td></td>
<td>Uses formal instruments</td>
<td>Researcher as instrument</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>Naturalistic</td>
</tr>
<tr>
<td></td>
<td>Deductive</td>
<td>Inductive</td>
</tr>
<tr>
<td></td>
<td>Component analysis</td>
<td>Searches for patterns</td>
</tr>
<tr>
<td></td>
<td>Seeks the norm</td>
<td>Seeks pluralism, complexity</td>
</tr>
<tr>
<td></td>
<td>Reduces data to numerical indices</td>
<td>Makes minor use of numerical indices</td>
</tr>
<tr>
<td></td>
<td>Uses abstract language in the write-up</td>
<td>Descriptive write-up</td>
</tr>
<tr>
<td><strong>Researcher Role</strong></td>
<td>Detachment</td>
<td>Personal involvement</td>
</tr>
<tr>
<td></td>
<td>Objective portrayal</td>
<td>Empathic understanding</td>
</tr>
</tbody>
</table>

The following research questions emerged from the Literature Review.

> What type of product design process (PDP) do SDC designers actually use?
> How and when can EcoDesign be integrated into this PDP?
> How do designers currently build skills and knowledge in SDCs?
> Which design tools are currently used, and do any of them consider EcoDesign?

What knowledge do designers have about Environmental Laws and Standards? It is clear that these questions do not fit a positivist approach, but are much more aligned with an interpretivist philosophy. However, the research ‘onion’, Figure 3.2, also makes reference to realism and pragmatism. There are several varieties of realism (Easterby-Smith et al., 2001) with each of the many prefixes, such as critical, direct, empirical,
metaphysical, and scientific (Jupp, 2006; Schwandt, 2001) representing often subtle differences in viewpoint. Nevertheless, realism shares two key features with positivism (Bryman, 2008), that reality exists independently of our perception of it and that the scientific method should be used in the development of knowledge (Saunders et al., 2009). So whilst realism is different from positivism the ontological and epistemological standpoints are very similar, see Table 3.3, reinforcing the alignment of this research to interpretivism.

Table 3.3: Comparison of Four Research Philosophies (Adapted from Saunders et al., 2009, p.119)

<table>
<thead>
<tr>
<th></th>
<th>Positivism</th>
<th>Realism</th>
<th>Interpretivism</th>
<th>Pragmatism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ontology</strong></td>
<td>External, objective and independent of social actors</td>
<td>Is objective. Independent of human thoughts and beliefs (realist), but is interpreted through social conditioning (critical realist)</td>
<td>Socially constructed, subjective, may change, multiple Constructionism</td>
<td>External, multiple, view chosen to best enable answering of the research question</td>
</tr>
<tr>
<td><strong>Epistemology</strong></td>
<td>Only observable phenomena can provide credible data, facts. Focus</td>
<td>Observable phenomena provide credible data. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which can be misinterpreted (critical realism)</td>
<td>Subjective meanings and social phenomena. Focus upon the details of the situation, a reality behind these details, Subjective meanings motivating actions</td>
<td>Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question.</td>
</tr>
<tr>
<td><strong>Methods and Techniques</strong></td>
<td>Highly structured, large samples, quantitative, but can use qualitative</td>
<td>Methods chosen must fit the subject matter, quantitative or qualitative</td>
<td>Small samples, in-depth investigations, qualitative</td>
<td>Mixed or multiple method designs, quantitative and qualitative</td>
</tr>
</tbody>
</table>

Pragmatism, as its name implies, is a more practical approach that argues that both the positivist and interpretivist approaches can be valid, depending upon what is being
investigated (Creswell, 2007). While this can be seen as the philosophical position that underpins a combined quantitative and qualitative, or mixed methods, approach (Denscombe, 2007) it has also been used by Corbin and Strauss (2008) as the foundation of grounded theory research. Grounded theory as a research strategy will be discussed further in Section 3.5, but it is useful to note at this stage that even the originators of grounded theory, Glaser and Strauss (1968), were ultimately unable to agree on their methodological approach (Glaser, 1992). Therefore, the philosophical stance of this research was based on the interpretivist view of the world and how to most appropriately conduct research in order to learn more about it.

3.2.2 Research Approach

In the context of the research ‘onion’, Figure 3.2, the approach refers to the relationship between theory and investigation, whether the approach is inductive or deductive (Saunders et al., 2009). A deductive strategy develops a theory that then guides the research leading to its validation, or otherwise. Whereas an inductive approach collects and analyses data in order to create a theory as its consequence (Richardson, 1996). Given that there was no pre-developed theory and that the purpose of this research was to understand SDCs better, and how EcoDesign principles might be integrated within them, an inductive approach was most appropriate. Having identified the research philosophy and approach it was important to identify answers to the following five questions (Robson, 2002).

> What are the purposes of the enquiry?
> What type of research is being carried out?
> What is the research strategy?
> What data collection techniques will be used?
> How will the data be analysed?

Although knowing the answers to certain aspects of these questions was necessary for the preceding sections, this was from a more conceptual perspective. The following sections take a more applied approach and define these questions more precisely, answering them as specifically as possible, to best describe the methodology used.
3.3 Research Purpose

The clarification of the research purpose is a useful way to derive the appropriate research methodology from the research questions (Robson, 2002). Marshall and Rossman (2011) classify the purposes of an enquiry in four ways: exploratory, explanatory, descriptive and emancipatory. A summary of these purposes and how they relate to general research questions is shown in Table 3.4. However, given the potential complexity of the situation being investigated, it is possible for a research project to have more than one purpose or the purpose of the enquiry may change over time (Saunders et al., 2009). This research is concerned with SDCs and understanding how they function, which factors influence their operation, and the barriers and drivers they face in the context of EcoDesign. Exploratory studies seek to understand what is happening and are particularly appropriate when the situation being studied is relatively unexplored (Gray, 2009).

Table 3.4: Matching Research Questions and Purpose (Marshall and Rossman, 2011, p.69)

<table>
<thead>
<tr>
<th>Purpose of the Study</th>
<th>General Research Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploratory</td>
<td></td>
</tr>
<tr>
<td>To investigate little-understood phenomena</td>
<td>What is happening in this social program?</td>
</tr>
<tr>
<td>To identify or discover important categories of meaning</td>
<td>What are the salient themes, patterns, or categories of meaning for participants?</td>
</tr>
<tr>
<td>To generate hypotheses for further research</td>
<td>How are these patterns linked with one another?</td>
</tr>
<tr>
<td>Explanatory</td>
<td></td>
</tr>
<tr>
<td>To explain the patterns related to the phenomenon in question</td>
<td>What events, beliefs, attitudes, or policies shape this phenomenon?</td>
</tr>
<tr>
<td>To identify plausible relationships shaping the phenomenon</td>
<td>How do these forces interact to result in the phenomenon?</td>
</tr>
<tr>
<td>Descriptive</td>
<td></td>
</tr>
<tr>
<td>To document and describe the phenomenon of interest</td>
<td>What are the salient actions, events, beliefs, attitudes, and social structures and processes occurring in this phenomenon?</td>
</tr>
<tr>
<td>Emancipatory</td>
<td></td>
</tr>
<tr>
<td>To create opportunities and the will to engage in social action</td>
<td>How do participants problematize their circumstances and take positive social action?</td>
</tr>
</tbody>
</table>

An important aspect of exploratory research is to ask questions, which cover many of the objectives developed in Chapter 1. The aspects of exploratory research can be matched more specifically to the list of objectives as shown below.
These are finding out what is happening, particularly in little-understood situations:

- To determine current practice and critically review the use of EcoDesign tools in industry.
- To identify the limitations of existing tools and why they are not more widely used.

This aims to understand the current situation and seek new insights:

- To understand the needs and aspirations of product designers when undertaking EcoDesign.

An important aspect of exploratory research is to ask questions and generate ideas and hypotheses for future research:

- To develop the requirements for an EcoDesign resource that has the potential to overcome these limitations.
- To create a prototype resource and refine it through an iterative process of user trials, modification and re-testing.

It was clear that the research has an exploratory nature, which in turn means that the research strategy needs to be flexible in order to accommodate any unexpected findings.

### 3.4 Research Type

Having decided upon the purpose of research being conducted, it was important to understand the type of information that should be collected. In this context data falls into two categories, quantitative or qualitative.

Table 3.5: Fundamental differences between quantitative and qualitative research strategies (Bryman, 2008, p.22)

<table>
<thead>
<tr>
<th></th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal orientation to the role of theory in relation to research</td>
<td>Deductive; testing of theory</td>
<td>Inductive; generation of theory</td>
</tr>
<tr>
<td>Epistemological orientation</td>
<td>Natural science model, in particular positivism</td>
<td>Interpretivism</td>
</tr>
<tr>
<td>Ontological orientation</td>
<td>Objectivism</td>
<td>Constructionism</td>
</tr>
</tbody>
</table>
Quantitative research generally uses statistical techniques to analyse empirical observations that have been recorded numerically and normally requires a predetermined theory or conceptual framework (Jupp, 2006; Neuman, 2007). Qualitative research investigates aspects of the world that are not easily quantified. It also implies an emphasis on interpretation of qualities of entities, and processes, that are not experimentally examined or measured (Denzin and Lincoln, 2008; Jupp, 2006). Table 3.5 provides additional detail on how these two categories fit within the ontological and epistemological orientation of the research. It is clear that when compared with the decision in Section 3.2.1 and Table 3.3, that the philosophical standpoint of this research project is both constructionist and interpretivist, hence research type is qualitative in nature. Table 3.6 gives greater detail on the practical differences between quantitative and qualitative research.

Table 3.6: Quantitative Research versus Qualitative Research (Neuman, 2007, p.88)

<table>
<thead>
<tr>
<th>Quantitative Research</th>
<th>Qualitative Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test hypothesis that the researcher begins with</td>
<td>Capture and discover meaning once the researcher becomes immersed in the data</td>
</tr>
<tr>
<td>Concepts are in the form of distinct variables</td>
<td>Concepts are in the form of themes, motifs, generalizations, and taxonomies</td>
</tr>
<tr>
<td>Measures are systematically created before data collection and are standardized</td>
<td>Measures are created in an ad hoc manner and are often specific to the individual setting or researcher</td>
</tr>
<tr>
<td>Data are in the form of numbers from precise measurement</td>
<td>Data are in the form of words and images from documents, observations, and transcripts</td>
</tr>
<tr>
<td>Theory is largely causal and is deductive</td>
<td>Theory can be causal or noncausal and is often inductive</td>
</tr>
<tr>
<td>Procedures are standard, and replication is assumed</td>
<td>Research procedures are particular, and replication is very rare</td>
</tr>
<tr>
<td>Analysis proceeds by using statistics, tables, or charts and discussing how what they show relates to hypotheses</td>
<td>Analysis proceeds by extracting themes or generalizations from evidence and organizing data to present a coherent, consistent picture</td>
</tr>
</tbody>
</table>

Quantitative techniques would have made it hard to understand the perspective of designers with any depth as they generally create outputs that are much more
detached from the individual participants (Brewer, 2007). Furthermore, in order to address the research objectives, and in particular, ‘To understand the needs and aspirations of product designers when undertaking EcoDesign’ it was necessary to use qualitative methods. Given the evolving nature of qualitative research and its inductive nature, it was expected that the research design would evolve with time (Robson, 2002). However, it was important to ensure sufficient objectivity through appropriate data collection techniques and analysis.

3.5 Research Strategy

There are many different research strategies (Creswell, 2007), some of these are shown in the research ‘onion’ Figure 3.2 as experiment, survey, case study, action research, grounded theory, ethnography and archival research. While some of these can be used for multiple research purposes including exploratory, explanatory, and descriptive research (Yin, 2009), others are clearly appropriate for either the deductive or inductive approach (Saunders et al., 2009). It was highlighted in Section 3.3 that exploratory research is likely to lead to a flexible design strategy. Flexible research implies that the process is iterative, and the research questions are likely to be modified as information emerges from the study (Davies, 2007). The five key flexible design research strategies that are identified by Creswell (2007) are narrative research, phenomenology, grounded theory, ethnography, and case study. A comparison of the focus and suitability of these strategies are shown in Table 3.7. It is clear that narrative approach would not be appropriate for this piece of research because it is concerned with exploring the life of an individual. Grounded theory was mentioned in Section 3.2.1 in the context of the research philosophy. With its origins in pragmatism (Corbin and Strauss, 2008), “grounded theory is an approach to research that was developed in response to concerns over the predominance of quantitative methods in social sciences and the tendency for research to be undertaken to test existing grand theories. Glaser and Strauss (1968, p.vii) perceived that there was an ‘embarrassing gap between theory and empirical research’. They proposed instead an inductive process in which theory is built and modified from the data collected” (Jupp, 2006, p.131).
Table 3.7: Contrasting Characteristic of Five Qualitative Approaches (Adapted from Creswell, 2007, pp.78-79)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Focus</th>
<th>Type of Problem Suitable</th>
<th>Form of Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative Research</td>
<td>Exploring the life of an individual</td>
<td>Needing to tell stories of individual experiences</td>
<td>Using primarily interviews and documents</td>
</tr>
<tr>
<td>Phenomenology</td>
<td>Understanding the essence of the experience</td>
<td>Needing to describe the essence of a lived phenomenon</td>
<td>Using primarily interviews with individuals, although documents, observations, and art may also be considered</td>
</tr>
<tr>
<td>Grounded Theory</td>
<td>Developing a theory grounded in data from the field</td>
<td>Grounding a theory in the views of participants</td>
<td>Using primarily interviews with 20-60 individuals</td>
</tr>
<tr>
<td>Ethnography</td>
<td>Describing and interpreting a culture-sharing group</td>
<td>Describing and interpreting the shared patterns of culture of a group</td>
<td>Using primarily observations and interviews, but perhaps collecting other sources during extended time in the field</td>
</tr>
<tr>
<td>Case Study</td>
<td>Developing an in-depth description and analysis of a case or multiple cases</td>
<td>Providing an in-depth understanding of a case or cases</td>
<td>Using multiple sources, such as interviews, observations, documents, artefacts</td>
</tr>
</tbody>
</table>

Whilst originally Glaser and Strauss (1968) described a very precise, systematic, way in which grounded theory should be applied, since its discovery many different approaches have evolved. The basis of all these approaches is the idea that a ‘theory’, rather than being proposed and investigated, should be inductively derived through an iterative process and therefore becomes increasingly ‘grounded’ in the data with each consecutive iteration (Bernard, 2000). While there are many elements of this research that are closely aligned with grounded theory, and despite there being some theorists that expect the starting point of an investigation to almost inevitably be influenced by the literature and personal experience (Corbin and Strauss, 2008), the objectives developed in Chapter 1 are too well defined to be considered grounded in the data. A case study is an empirical inquiry that “investigates a contemporary phenomenon in
depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 2009, p.18). Case studies can be exploratory or explanatory (Saunders et al., 2009) but in order not to be overwhelmed with data they require focus (Yin, 2009), which in turn often makes them more appropriate for the validation of early phase research and hence more deductive (Gray, 2009). Along with some of the practical difficulties of conducting case studies in SDCs, such as extended examination of designers at work and the related issues of client confidentiality, their use could have limited the scope of exploration to a relatively small number of SDCs. Phenomenology assumes that any understanding of reality has to be grounded in the experience people have of that reality (Gray, 2009) and it seeks to gain insight into those phenomena (Saunders et al., 2009).

The preceding sections have explained that the research was carried out from an interpretivist, constructionist standpoint and, as shown in Table 3.3, this standpoint directly leads to the study of meanings and phenomena. Constructionism and phenomenology are heavily intertwined (Gray, 2009), but there is a distinction between phenomenology as a theoretical perspective and phenomenological research as a methodological strategy (Crotty, 1998). So while ethnography also studies phenomena, its extensive use of observation distinguishes it from phenomenological research, which almost exclusively uses interviews (Gray, 2009). Table 3.8 summarises the differences between phenomenological research and ethnography.

Table 3.8: Distinctions between Phenomenological Research and Ethnography (Gray, 2009, p.24)

<table>
<thead>
<tr>
<th>Ethnography</th>
<th>Phenomenological Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study of culture</td>
<td>Study of the ‘lifeworld’ human experience</td>
</tr>
<tr>
<td>Discovering the relationship</td>
<td>Exploring the personal construction of the</td>
</tr>
<tr>
<td>between culture and behaviour</td>
<td>individual’s world</td>
</tr>
<tr>
<td>Studying 'sites'</td>
<td>Studying individuals</td>
</tr>
<tr>
<td>As many informants as possible</td>
<td>Between 5 and 15 'participants'</td>
</tr>
<tr>
<td>Use of observation, and some</td>
<td>Use of in-depth, unstructured interviews</td>
</tr>
<tr>
<td>interviewing</td>
<td></td>
</tr>
<tr>
<td>Unit of analysis: event</td>
<td>Unit of analysis: meaning unit</td>
</tr>
<tr>
<td>Reliability: triangulation</td>
<td>Reliability: confirmation by participants</td>
</tr>
</tbody>
</table>
Whilst some of the distinctions between ethnography and phenomenological research are subtle, much like case studies, the practicalities of conducting a proper ethnographic study of multiple SDCs was prohibitive. Ethnography would have required wide-ranging access to the SDC sites for an extended period of time, from several weeks to more than a year (Angrosino, 2007) and gaining consent for this type of long-term observation would not have been possible, especially with issues of client confidentiality. Therefore, a phenomenological research strategy was adopted, and this determined the data collection techniques that could be used.

Figure 3.3, the research methodology guide, shows a detailed view of the research process map, Figure 3.1, highlighting the decisions made concerning research philosophy, research approach, research purpose, research type and research strategy.

Figure 3.3: Research Methodology Guide
3.6 Data Collection Technique

The objective of phenomenology research is to investigate an event, or phenomenon, and the nature of that experience rather than the characteristics of those who had the experience. Phenomenology is also focused on the description of events rather than the creation of theories about their causal explanations (Polkinghorne, 1989). Qualitative research allows for many different sources of data to be used, such as interviews, observations, videos, documents, drawings, diaries, memoirs, newspapers, biographies and questionnaires (Corbin and Strauss, 2008). This can be summarised as watching, asking and looking for other evidence, such as documents (Robson, 2002). Equally, the ways that qualitative data is collected can be considered to fall into two main groups: survey based and observation based (Davies, 2007). Survey based techniques include questionnaires, interviews, user diaries and focus groups. Observation-based methods include ethnographic research, but this approach was rejected in Section 3.5. It is important to select appropriate sample groups when carrying out survey based research, but it is also necessary to use a suitable method of data collection. The method depends on several factors, with the main feature being dependent on the aim of the survey. The selection of which method to apply can be determined using the following rules (Robson, 2002, p.224).

- To find out what people do in public, use direct observation.
- To find out what they do in private, use interviews or questionnaires.
- To find out what they think, feel and/or believe, use interviews, questionnaires or attitude scales.
- To determine their abilities, or measure their intelligence or personality, use standardised tests.

In addition, different data collection activities are linked to different research strategies (Creswell, 2007). Having established in the previous sections that phenomenology was the appropriate strategy, Table 3.9 shows a suitable way to collect and capture this type of data.
Table 3.9: Data Collection Activities Based upon Strategy (Section of Creswell, 2007, pp.120-121)

<table>
<thead>
<tr>
<th>Data Collection Activity</th>
<th>Phenomenology</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is traditionally studied? (sites or individuals)</td>
<td>Multiple individuals who have experienced the phenomenon</td>
</tr>
<tr>
<td>What are typical access and rapport issues? (access and rapport)</td>
<td>Finding people who have experienced the phenomenon</td>
</tr>
<tr>
<td>How does one select a site or individuals to study? (purposeful sampling strategies)</td>
<td>Finding individuals who have experienced the phenomenon, a &quot;criterion&quot; sample</td>
</tr>
<tr>
<td>What type of information typically is collected? (forms of data)</td>
<td>Interviews with 5 to 25 people (Polkinghorne, 1989)</td>
</tr>
<tr>
<td>How is information recorded? (recording information)</td>
<td>Interviews, often multiple interviews with the same individuals</td>
</tr>
<tr>
<td>What are common data collection issues? (field issues)</td>
<td>Bracketing one’s experiences, logistics of interviewing</td>
</tr>
<tr>
<td>How is information typically stored? (storing data)</td>
<td>Transcriptions, computer files</td>
</tr>
</tbody>
</table>

When the information from Table 3.7 (Creswell, 2007), Table 3.8 (Gray, 2009) and Table 3.9 (Creswell, 2007) are considered alongside the four rules from Robson (2002), it is clear that interviews were the appropriate technique for this type of investigation.

3.6.1 Interviews

Qualitative research interviews are a method for understanding the world from the point of view of the participant and, through a type of structured conversation, developing insight through their experiences (Kvale and Brinkmann, 2009). Generally, interviews are described as structured, semi-structured or unstructured, though the term in-depth interview is sometimes substituted for unstructured (Saunders et al., 2009) or even as an umbrella term for semi-structured or unstructured (Bryman, 2008; Rubin and Rubin, 2012). This inconsistency is due in part to the realities of conducting interviews, which actually exist on a continuum (Punch, 2005) like that shown in Figure 3.4.
Structured Interviews | Semi-structured or Focused Interviews | Unstructured Interviews
---|---|---
Standardized Interviews | In-depth Interviews | In-depth Interviews
Survey Interviews | Survey Interviews | Clinical Interviews
Clinical History Taking | Group Interviews | Group Interviews
Oral or Life History Interviews | In-depth Interviews | Oral or Life History Interviews

Figure 3.4: The Continuum Model for Interviews (Minichiello et al., 1992, p.267)

In addition, where interviews fall along this line may vary depending on the stage the research has reached (Arksey and Knight, 1999). In order to best clarify the terminology, in this thesis, the characteristics of structured, semi-structured and unstructured interviews are defined in Table 3.10.

Table 3.10: Characteristics of Structured, Semi-structured and Unstructured Interviews (Adapted from Arksey and Knight, 1999, pp.7-9)

<table>
<thead>
<tr>
<th>Structured</th>
<th>Semi-structured</th>
<th>Unstructured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions all agreed in advance. Interviewers must stick rigidly to a script</td>
<td>Main questions and script are fixed, but interviewers can improvise follow-up questions to explore areas of interest that emerge</td>
<td>The interviewer may have a list of broad topics or themes to explore. The direction is largely set by the informant</td>
</tr>
<tr>
<td>Used only for collecting standard information about informants</td>
<td>Most common qualitative interviews, where desire to hear what informants have to say on topics and areas identified by the researcher</td>
<td>Most often used early in a study with the intention of generating a script for subsequent, semi-structured enquiries</td>
</tr>
<tr>
<td>Quick to data capture</td>
<td>Slow and time-consuming to data capture and analyse</td>
<td>Slow and time-consuming to capture/analyse data</td>
</tr>
<tr>
<td>Use of random sampling</td>
<td>The longer the interview, the more advisable it is to use random sampling</td>
<td>Opportunity and snowball sampling often used. In organizations, targeting of ‘key informants’</td>
</tr>
<tr>
<td>Interview schedule followed exactly</td>
<td>Interviewer refers to guide containing a mixture of open and closed questions. Interviewer improvises using own judgement</td>
<td>The interviewer uses aide-mémoire of topics for discussion and improvises</td>
</tr>
<tr>
<td>Interviewer-led</td>
<td>Sometimes interviewer-led, sometimes informant-led</td>
<td>Non-directive interviewing</td>
</tr>
<tr>
<td>Tends to positivist view of knowledge</td>
<td>A mixture of positivist and non-positivist</td>
<td>Non-positivist view of knowledge</td>
</tr>
</tbody>
</table>
Whilst the names of the three types of interview, structured, semi-structured and unstructured, would appear to make their descriptions self-explanatory, the term unstructured is somewhat misleading. Much like grounded theory, discussed in Section 3.5, for the data gathered to be at all relevant to the research questions it cannot be completely devoid of structure (Britten, 1995).

There are advantages and disadvantages in using interviews rather than other types of survey, such as questionnaires and focus groups (Robson, 2002). The main benefits are that semi-structured and unstructured interviews are flexible and have the potential to provide rich and detailed information that might not be achieved with questionnaires, especially when the research is exploratory (Cohen et al., 2007). This flexibility allows for follow-up questions to be asked when there is an interesting or unexpected response from the interviewee (Denscombe, 2007). However, the potential for such a richness of data requires a large investment of time in recruiting participants, conducting interviews and the analysis of their outcomes (Saunders et al., 2009). There is also a level of skill required by the interviewer and a good understanding of the research problem to get the best results from in-depth interviews (Ghauri and Grønhaug, 2005). In-depth interviews make use of open-ended questions, see Table 3.11 below, which give the interviewee an opportunity to respond in a way in which they chose, including disagreeing with the question (Rubin and Rubin, 2012).
Table 3.11: Checklist for Deciding Between Open and Closed-Ended Questions (Fink, 2003, p.38)

<table>
<thead>
<tr>
<th></th>
<th>If Yes, Use Open-Ended Questions</th>
<th>If Yes, Use Closed-Ended Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Respondents’ own words are essential (to please respondent, to obtain quotes, to obtain testimony)</td>
<td>You want data that are rated or ranked (on a scale of very poor to very good, for example), and you have a good idea of how to order the ratings in advance</td>
</tr>
<tr>
<td><strong>Respondent characteristics</strong></td>
<td>Respondents are capable of providing answers in their own words</td>
<td>You want respondents to answer using a pre-specified set of response choices</td>
</tr>
<tr>
<td></td>
<td>Respondents are willing to provide answers in their own words</td>
<td></td>
</tr>
<tr>
<td><strong>Asking the question</strong></td>
<td>You prefer to ask only the open question because the choices are unknown</td>
<td>You prefer that respondents choose among known choices</td>
</tr>
<tr>
<td><strong>Analyzing the results</strong></td>
<td>You have the skills to analyze respondents’ comments even though answers may vary considerably</td>
<td>You prefer to count the number of choices</td>
</tr>
<tr>
<td></td>
<td>You can handle responses that appear infrequently</td>
<td></td>
</tr>
<tr>
<td><strong>Reporting the results</strong></td>
<td>You will provide individual or grouped verbal responses</td>
<td>You will report statistical data</td>
</tr>
</tbody>
</table>

Despite some of the constraints, it was clear that in-depth interviews were the appropriate way to investigate exploratory, qualitative, phenomenological questions. This does potentially include the use of semi-structured and unstructured interviews, but the preceding chapters established a set of topics to explore with a level of structure too great to be considered unstructured, hence the use of semi-structured interviews.

Qualitative, semi-structured, interviews are characterised by their openness and flexibility, meaning that there are no standard procedures for conducting this type of research interview (Brinkmann and Kvale, 2015). However, Table 3.12 presents the
seven stages of an interview inquiry, which describes the choices the researcher needs to make at different stages of the investigation (Kvale, 2007). Thematizing involved clarifying the purpose of a study, as described in Section 3.3. The design of the study was built around the principles outlined in this portion of the thesis, Section 3.6, as are the other stages of the inquiry.

Table 3.12: Seven Stages of an Interview Inquiry (Kvale, 2007, pp.35-36)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thematizing</td>
<td>Formulate the purpose of an investigation and the conception of the theme to be investigated before the interviews start. The why and what of the investigation should be clarified before the question of how-method-is posed</td>
</tr>
<tr>
<td>Designing</td>
<td>Plan the design of the study, taking into consideration all seven stages of the investigation, before interviewing. Designing the study is undertaken with regard to obtaining the intended knowledge and taking into account the moral implications of the study</td>
</tr>
<tr>
<td>Interviewing</td>
<td>Conduct the interviews based on an interview guide and with a reflective approach to the knowledge sought and the interpersonal relation of the interview situation</td>
</tr>
<tr>
<td>Transcribing</td>
<td>Prepare the interview material for analysis, which generally includes a transcription from oral speech to written text</td>
</tr>
<tr>
<td>Analyzing</td>
<td>Decide, on the basis of the purpose and topic of the investigation and of the nature of the interview material, which modes of analysis are appropriate for the interviews</td>
</tr>
<tr>
<td>Verifying</td>
<td>Ascertain the validity, reliability, and generalizability of the interview findings. Reliability refers to how consistent the results are, and validity means whether an interview study investigates what is intended to be investigated</td>
</tr>
<tr>
<td>Reporting</td>
<td>Communicate the findings of the study and the methods applied in a form that lives up to scientific criteria, takes the ethical aspects of the investigation into consideration, and results in a readable product</td>
</tr>
</tbody>
</table>

3.6.1.1 Telephone and Internet Interviews

Typically semi-structured interviews are conducted on a face-to-face basis. However, it may be necessary to carry out such qualitative interviews over the phone or electronically via the internet using Voice over IP (VoIP) software like Skype (2011), (King and Horrocks, 2010). The reasons for using telephone or internet interviews can often
be due to the time and cost of visiting participants, though the participant may have a personal preference for being interviewed in this way (Shuy, 2002). There is also some evidence that suggests that for in-person interviews the replies given by the respondent can be affected by the characteristics of the interviewer, but this less likely for telephone interviews (Bryman and Bell, 2011). When telephone interviews are the only method of conducting research, it may deter some participants from taking part and create a bias in the data sample (Oppenheim, 1992). However, if participants are given a choice of face-to-face or telephone interview having already agreed to participate in the study, this is much less of an issue (Arksey and Knight, 1999). There are some additional technical difficulties created when conducting telephone and internet studies because it is more complicated to record these interviews and there is potential for the connection to experience interference or be disconnected (Saunders et al., 2009). During telephone interviews, the non-verbal behaviour of the participant cannot be discerned, which may affect the way responses are interpreted (Cohen et al., 2007), but equally not being able to see the participant can ameliorate the natural inclination of the interviewer to fill pauses with their own interjections.

3.6.1.2 Sample Size

Before conducting a study, it is very difficult to know how many interviews are necessary to find answers to the research question(s) being investigated (Kvale, 2007). When collecting quantitative data there are probabilistic, statistical formulae that can be applied to calculate this, but these are not applicable for non-probabilistic samples (Guest et al., 2006). The purpose of probability based sampling is that a statistically representative sample can be used for generalisation to the larger population. However, by selecting information-rich cases for in-depth study, substantial amounts can be learnt about the central question posed by a qualitative study (Dillman et al., 2014). These sorts of sample are called ‘purposeful’ because they reveal considerable amounts of information which are important for the purpose of the research (Patton, 1990). For qualitative research generalisations are made about the underlying theory, rather than the wider population from which the sample comes hence the sample size is dependent upon the objectives of the research (Saunders et al., 2009) in particular “sample size depends on what you want to know, the purpose of the inquiry, what’s at stake, what will be useful, what will have credibility, and what can be done with available time and resources” (Patton, 1990, p.184). While this may be true, it is useful to have
some way of estimating the number of participants needed to be recruited in order to conduct a meaningful interview study. The main guiding principle for these non-probabilistic purposive samples is that interviews should continue to be carried out until the additional data collected data does not shed any further light on the issue under investigation (Guest et al., 2006). This is known as ‘saturation’ (Glaser and Strauss, 1968) and is the point at which more interviews provide little, or no, new information. However useful saturation is as a measure of participant numbers, at the conceptual level, it can only tell the researcher whether they have enough data once they are analysing it. Morse (1994, p.147) observed that “saturation is the key to excellent qualitative work,” but also noted that “there are no published guidelines or tests of adequacy for estimating the sample size required to reach saturation.” So, unlike a quantitative, probabilistic, study there are no statistical formulae that can be applied to find the point of data saturation for a particular study. However, there are some guidelines for the number of interviews required for data saturation, as shown in Table 3.13, based on the outcomes of numerous studies conducted in the past.

Table 3.13: Number of Interviews Required for Data Saturation

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>No. of Interviews for Data Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creswell (2007, pp.120-121)</td>
<td>5 to 25 People</td>
</tr>
<tr>
<td>Gray (2009, p.24)</td>
<td>Between 5 and 15 Participants</td>
</tr>
<tr>
<td>Guest et al. (2006, p.1)</td>
<td>12 Interviews</td>
</tr>
<tr>
<td>Kvale and Brinkmann (2009, p.140)</td>
<td>15 +/- 10 Interviews</td>
</tr>
<tr>
<td>Morse (1994, p.225)</td>
<td>At Least 6 Participants</td>
</tr>
<tr>
<td>Polkinghorne (1989, p.48)</td>
<td>25 to 30 Interviews (Mid-sized Study)</td>
</tr>
</tbody>
</table>

The estimates in Table 3.13 average out at approximately 15 participants for a medium sized qualitative study to reach data saturation.
In addition to knowing the number of participants required for a study, it is also necessary to have a strategy for choosing them. As shown in Figure 3.5 there are a variety of sampling strategies.

![Sampling Techniques Diagram](image)

**Figure 3.5: Sampling Techniques (Adapted from Saunders et al., 2009, p.213)**

Criterion sampling uses predetermined criteria, which are considered necessary, to select participants. Individuals are selected based on the presumption that they possess knowledge and experience of the phenomenon of interest and thus will be able to provide information that is both detailed and generalizable, much like probability sampling (Palinkas et al., 2015). The non-probability sampling techniques are defined in Table 3.14.
Table 3.14: Non-probability Sampling Strategies  (Adapted from Patton, 1990, p.182)

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Extreme or Deviant Case Sampling</td>
<td>Learning from highly unusual manifestations of the phenomenon of interest, such as outstanding successes/ notable failures, top of the class/ dropouts, exotic events, crises</td>
</tr>
<tr>
<td>2. Intensity Sampling</td>
<td>Information-rich cases that manifest the phenomenon intensely, but not extremely, such as good students/ poor students, above average/below average</td>
</tr>
<tr>
<td>3. Homogeneous Sampling</td>
<td>Focuses, reduces variation, simplifies analysis, facilitates group interviewing</td>
</tr>
<tr>
<td>4. Typical Case Sampling</td>
<td>Illustrates or highlights what is typical, normal, average</td>
</tr>
<tr>
<td>5. Critical Case Sampling</td>
<td>Permits logical generalization and maximum application of information to other cases because if it is true of this one case, it is likely to be true of all other cases</td>
</tr>
<tr>
<td>6. Criterion Sampling</td>
<td>Determines a list of characteristics that are essential for eligibility to form part of the sample</td>
</tr>
<tr>
<td>7. Confirming and Disconfirming Cases</td>
<td>Elaborating and deepening initial analysis, seeking exceptions, testing variation</td>
</tr>
<tr>
<td>8. Opportunistic Sampling</td>
<td>Following new leads during field-work, taking advantage of the unexpected, flexibility</td>
</tr>
<tr>
<td>9. Convenience Sampling</td>
<td>Saves time, money, and effort. Subjects are selected because of their convenient accessibility and proximity to the researcher</td>
</tr>
<tr>
<td>10. Combination or Mixed Purposeful Sampling</td>
<td>Triangulation, flexibility, meets multiple sampling interests and needs</td>
</tr>
</tbody>
</table>

Convenience sampling is a non-probability sampling procedure in which cases are selected on the basis that they are the most straightforward to obtain. Information is collected from participants who are readily available to the researcher (Palinkas et al., 2015). Convenience samples may well also have a set of characteristics that correlate with a subset of an associated criterion sample.
3.6.2 Survey Questionnaires

As shown in Figure 3.2, a survey is a research strategy, rather than a specific method of data collection (Robson, 2002). Although questionnaires are widely used for surveys, other techniques such as interviews and observations can also be considered types of survey (de Vaus, 1996). Often there is a very close resemblance between the list of questions used for an interview and a questionnaire (Trochim and Donnelly, 2008) especially if the questionnaire includes open-ended questions (Bourque and Fielder, 2003). In most respects, a structured interview is a questionnaire that is administered by the interviewer, and in the case of online surveys, they are almost impossible to distinguish (Bryman, 2008). Given the clear overlap between interviews and questionnaires, there are some instances where these two types of survey are interchangeable.

Online questionnaires share many advantages with telephone interviews, especially regarding time and cost of data collection (Bourque and Fielder, 2003). Questionnaires are usually faster to administer, analyse and are better suited to hypothesis testing than interviews (Brinkmann and Kvale, 2015), but there are also limitations. Questionnaires have the potential to be impersonal and limit the level of detail in their responses, so are not necessarily appropriate for explorative research questions (Sommer and Sommer, 1997). However, this is not necessarily a problem if the questionnaire is being used to provide feedback on something specific that all the participants have access to and has a defined and limited scope (Goodman et al., 2012). If online questionnaires are sent out to a general sample group, there is potential for participants to be self-selecting around their technical knowledge and ability to complete the questionnaire unaided (Bourque and Fielder, 2003), but this may not be a problem if the sample group is known not to have any of these impediments.

3.6.3 Research Ethics

In the context of research, ethics refers to moral principles guiding research, and to the appropriateness of behaviour towards participants (Saunders et al., 2009). There are a number of slightly different lists of ethical principles that should be followed when conducting research (Bryman, 2008; ESRC, 2015; Flick, 2007; Gray, 2009; Hesse-Biber and Leavy, 2006; Robson, 2002; Saunders et al., 2009) but many of these are adapted from Patton (2002) as shown in Table 3.15. In the context of this research, the main ethical issues were privacy, confidentiality, informed consent and data access.
Table 3.15: Key Issues of Ethical Research (Adapted from Patton, 2002, p.408)

<table>
<thead>
<tr>
<th>Ethical Issue</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privacy</td>
<td>The right not to participate. The right to be contacted at reasonable times and to withdraw at any time</td>
</tr>
<tr>
<td>Promises and Reciprocity</td>
<td>What do participants gain from cooperating with the research? If promises are made (such as a copy of the final report) keep them</td>
</tr>
<tr>
<td>Risk Assessment</td>
<td>In what ways will the research put people under psychological stress, legal liabilities, ostracism by peers or others? Will there be political repercussions? How will you plan to deal with these risks?</td>
</tr>
<tr>
<td>Confidentiality</td>
<td>What constitutes the kinds of reasonable promises of confidentiality that can be honoured in practice? Do not make promises that cannot be kept</td>
</tr>
<tr>
<td>Informed Consent</td>
<td>What kind of formal consent is necessary and how will it be obtained?</td>
</tr>
<tr>
<td>Data Access and Ownership</td>
<td>Who will have access to the data and who owns it? Make sure that this is specified in any research contract</td>
</tr>
<tr>
<td>Researcher Mental Health</td>
<td>How will the researcher be affected by conducting the research? What will they see or hear that may require debriefing or counselling?</td>
</tr>
<tr>
<td>Advice</td>
<td>Who will the researcher use as a confidant(e) or counsellor on issues of ethics during the research?</td>
</tr>
</tbody>
</table>

Before conducting research with human participants, an Ethical Clearance Checklist had to be completed in accordance with the Loughborough University Ethics Approvals (Human Participants) Sub-Committee guidelines. The investigation was deemed to conform to the ethical checkpoints and thus authorised to proceed. Each participant was informed of the purpose and details of the study prior to their involvement. A Participant Information Sheet was given to participants to read before their interview began. This included explanations of the right to withdraw, and that all information on participants would be treated as confidential and any reference to people or organisations would also be removed. The Participant Information Sheet also included instructions on what to do if participants were unhappy with the way research was conducted. If they agreed having read this, participants were asked to complete an Informed Consent Form. Copies of both of these documents can be seen in Appendix E.
3.7 Main Study and Pilot Survey

It was essential to get a general overview of the field before making a detailed research plan. This was achieved with a pilot study and, as discussed in Section 3.6.1, the most appropriate data collection technique was semi-structured interviews. This has the advantage of using some predetermined questions, but with the flexibility to modify these based on the responses of the interviewee (Robson, 2002). This was important because at this early stage ideas were still being developed.

Participatory observation would have taken too long to set up in more than one SDC. Non-participatory or covert observation could have been more appropriate techniques (Angrosino, 2007). However, although a covert investigation could have been more likely to capture natural behaviour, there are many technological and ethical barriers to this particular method (Angrosino, 2007). Also, many SDCs are working on commercially sensitive projects, and blanket data capture would not have given participants the control that interviews offer.

3.7.1 Selection of Participants

Given the discussion of samples in Section 3.6.1.2, a purposive, criterion sample of 15-25 participants was sought. This meant that participants were selected for a specific purpose, following certain criteria. 15 participants was the best estimate for the minimum number of interviewees required for data saturation.

In the introduction, a small design consultancy (SDC) was defined as a company that has more than one, but fewer than 50 employees and this particular study was limited to the UK. These criteria were used to select companies that would be approached to ask if they might be involved in the research. A number of different ways were used to find potential participants. Initially, this was through existing industrial links that Loughborough Design School maintained. However, this only provided a limited number of participants. The majority of participants were recruited through personal, professional contacts and use of the internet. Knowing some professional designers personally gave a starting point for recruitment. Some of these people fitted the criteria and agreed to participate, and also recommended other companies that might like to be involved. SlideShare (2006), a business oriented social networking service, also provided a list of potential participants. Not only does LinkedIn allow connections to be made with people you do not know via people you do, but it also facilitates group based communication. There are groups such as Product Design, UK Industrial Design
and the Design Council which contain tens of thousands of members that can be contacted through discussion posts. Through a combination of contacts, recommendations and social networking an initial list of companies was created, which was then filtered through an evaluation of their websites and online portfolios. Ultimately 26 participants were recruited from 22 different design consultancies. The pilot study comprised of five designers from five different consultancies. The main study was composed of 20 designers and one design researcher from 18 different consultancies.

> Pilot Study - 5 Designers | 5 Consultancies

> Main Study - 20 Designers | 1 Design Researcher | 18 Consultancies

The participants had an average of ten years’ professional experience with a range of two to thirty years. The participants worked in SDCs based in London, The South East/West, The Midlands and Wales. Half of these companies had up to eight employees, and the rest had 30-50 employees. In order to anonymise the designers when quoting from their interviews, they have been designated codes starting with ‘Des’ followed by a letter from A-Z representing the order in which they were interviewed and a suffix of ‘p’ has been added to those involved in the pilot, and ‘m’ for those involved in the main study. A similar system was used to substitute for company names. Some examples of how these codes work are shown in Table 3.16, full details of the participant and company and codes can be found in Appendix F.

Table 3.16: Examples of Participant and Company and Codes for Analysis

<table>
<thead>
<tr>
<th>Participant Code</th>
<th>Description of Participant</th>
<th>Experience (Years)</th>
<th>Size</th>
<th>Company Location</th>
<th>Company Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>DesA-p</td>
<td>Product Designer</td>
<td>15</td>
<td>8</td>
<td>London</td>
<td>ComA-p</td>
</tr>
<tr>
<td>DesB-p</td>
<td>Product Designer/Founder</td>
<td>7</td>
<td>3</td>
<td>London</td>
<td>ComB-p</td>
</tr>
<tr>
<td>DesC-p</td>
<td>Product Designer/Director</td>
<td>25</td>
<td>2</td>
<td>Windsor</td>
<td>ComC-p</td>
</tr>
<tr>
<td>DesD-p</td>
<td>Product Designer/Director</td>
<td>18</td>
<td>3</td>
<td>London</td>
<td>ComD-p</td>
</tr>
<tr>
<td>DesE-p</td>
<td>Product Designer/Co-founder</td>
<td>8</td>
<td>3</td>
<td>London</td>
<td>ComE-p</td>
</tr>
<tr>
<td>DesF-m</td>
<td>Product Designer</td>
<td>8</td>
<td>~50</td>
<td>London</td>
<td>ComF-m</td>
</tr>
<tr>
<td>DesG-m</td>
<td>Product Designer/Co-founder</td>
<td>10</td>
<td>4</td>
<td>London</td>
<td>ComG-m</td>
</tr>
<tr>
<td>DesH-m</td>
<td>Product Designer/Co-founder</td>
<td>10</td>
<td>3</td>
<td>London</td>
<td>ComH-m</td>
</tr>
<tr>
<td>DesI-m</td>
<td>Senior Designer</td>
<td>10</td>
<td>~45</td>
<td>London</td>
<td>ComI-m</td>
</tr>
<tr>
<td>ResJ-m</td>
<td>Senior Cultural Researcher</td>
<td>5</td>
<td>~45</td>
<td>London</td>
<td>ComJ-m</td>
</tr>
</tbody>
</table>
3.7.2 Interview Process

The majority of interviews were face-to-face and conducted at the place of work of the participants. However, for the convenience of the participant, some interviews took place over the telephone or electronically with the internet using VoIP software. All interviews were recorded with the permission of the interviewees and transcribed verbatim. As part of the recruitment process, as much information was ascertained as possible about the SDCs, to decide if they met the research criteria. In addition, this information was useful when conducting the interview process. Prior to agreeing to their involvement, participants were advised that interviews should take approximately 45 minutes.

3.7.2.1 Pilot Study

Having established in Section 3.6 that semi-structured interviews were the best method to investigate the research questions, a pilot study was conducted. The pilot study was used to help develop a set of open questions to prompt discussion, and that allowed respondents to explore themes further. Five participants were chosen who met the criteria outlined in Section 3.7.1, and who were willing and able to take part at this early stage of the research.

Initially, there were three questions:

> How does the briefing process work?

> How does the company find information?

> How do you judge the reliability of information?

Through the process of conducting the pilot study, and based on the responses given, additional and more nuanced questions were added. More details of this process can be seen in Appendix G.

3.7.2.2 Main Study

The face-to-face interviews all followed a similar process. After initial introductions, most interviews were preceded by a tour of the company though there were generally areas that could not be visited where commercially sensitive work was being done. These tours were useful because they helped illuminate aspects of how the companies worked and gave indications about their design process. Once these preliminaries had been completed a quiet space was found to conduct the interview. The interviewees
were given the Participant Information Sheet to read, allowed to ask any questions and signed the Informed Consent Form. Copies of both of these documents can be seen in Appendix E. A digital recording device was set up having checked that the participant was still happy to have the interview retained in this way. Interviewer and interviewee were given separate microphones, which were connected to two different channels, and that could be clipped to their clothing. This was found to provide the best audio quality for reviewing the interviews and for their transcription. Notes were also taken, partly as a backup in case the recording equipment failed, but also to document the thoughts of the researcher, and to highlight parts of the recording that might be of particular interest. Examples of these notes can be seen in Appendix H.

The process was slightly different for the remote interviews. The preliminary process tended to be shorter because there was no opportunity to tour the workplace. However, it was important to establish rapport with the interviewee, especially as this was done only with an audio connection. Video connections were considered to provide a less reliable communication link and so were avoided. Initially, some time was spent in more conversational exchanges to put the interviewees at ease so that the interview process was more relaxed, and ultimately the participants were more forthcoming. The Participant Information Sheet and Informed Consent Form were emailed before the interviews, signed and returned electronically. Technologies were used that could record these phone and VoIP conversations, having checked that this was acceptable for the participant. Written notes were also taken.

The advice that the interviews should take approximately 45 minutes was a good estimate, but some interviews ran longer when the participants were willing and able to discuss the topics further. The pilot study helped to clarify and expand the interview questions, ultimately leading to five main questions:

- How does your company work?
- What is the company product design process (PDP)?
- How does your company learn?
- What does EcoDesign mean to you?
- What do you know about Eco Laws?

Each of these questions was subdivided into further questions giving an additional 20 questions that could be used to help clarify or expand the responses given to the main
questions. Full details can be seen in Appendix H, and this includes examples of the handwritten notes taken during the interviews.

### 3.7.3 Resource Evaluation Process

The resource, ‘d.eco’, described in Chapter 5 required evaluation in order to confirm whether the guiding principles used to create it were suitable and if it appropriately embodied the findings of Chapter 4. To gain feedback from the initial participants, an online survey method was chosen. As discussed in Section 3.6.2 online questionnaires are comparatively fast and efficient to administer and analyse especially when respondents come from a wide geographic area. Having contacted them by email, nine of the original main study interviewees agreed to take part in the evaluation process. In addition, seven new participants were recruited, three of whom were used to pilot d.eco and the survey process before it was rolled out to all the participants. These new contributors were recruited in the same ways as described in Section 3.7.1. The original participants kept their original designation, but the suffix was changed to ‘v’ for validation, for example, DesC-v. New contributors were given codes starting with ‘Des’ followed by a letter from AA-AZ representing the order in which they were contacted. A suffix of ‘vp’ has been added to those involved in the validation pilot. Further details of these participants can be found in Appendix I.

The survey was created online using SurveyMonkey (2017) because of the features accessible using the subscription version available through the Loughborough Design School. This version of SurveyMonkey includes a database of certified questions which were created by survey methodologists to give the best responses and minimise bias. It also provides customisable graphic themes, making it more visually appealing, which could contribute to better engagement with designers. The survey included some basic questions about the participants, followed by five open-ended qualitative questions, with associated quantitative rating scales, about the efficacy of d.eco resource. The main questions were about Visual Engagement, Inspiration, Communication and Accountability. A full list of the questions asked can be found in Appendix J.

Having agreed to take part, participants were sent an email containing links to the d.eco website and the online survey. A set of basic instructions were also attached to the email, and can be seen in Appendix J. The introduction of the survey included participant information, including the right to withdraw, and that all information would
be treated as confidential. Participants replied in their own time over a period of two weeks.

3.7.4 Data Analysis

Data analysis is the process of breaking down data into its constituent components, to reveal its characteristic elements and structure (Dey, 1993). This facilitates the retrieval and organisation of data elements so that they can be analysed (Blessing and Chakrabarti, 2009). Given the diversity of data collected in qualitative research it is not necessarily possible to apply a standardised analysis process, rather a tailored approach needed to be developed that best suited the collected material (Creswell, 2007). However, there is a general approach known as thematic analysis which can be used with most, if not all, qualitative methods (Boyatzis, 1998). Thematic analysis is a process of encoding qualitative data, splitting them into different groups of codes to form themes or patterns found in the data (Boyatzis, 1998). Having established these codes, it is then the process of analysing and interpreting the themes according to the research questions. The phases of thematic analysis, as described by Braun and Clarke (2006) can be seen in Table 3.17.

Table 3.17: Phases of Thematic Analysis (Braun and Clarke, 2006, p.87)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description of the Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiarizing yourself with your data</td>
<td>Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas</td>
</tr>
<tr>
<td>Generating initial codes</td>
<td>Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code</td>
</tr>
<tr>
<td>Searching for themes</td>
<td>Collating codes into potential themes, gathering all data relevant to each potential theme</td>
</tr>
<tr>
<td>Reviewing themes</td>
<td>Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic ‘map’ of the analysis</td>
</tr>
<tr>
<td>Defining and naming themes</td>
<td>Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme</td>
</tr>
<tr>
<td>Producing the report</td>
<td>The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis</td>
</tr>
</tbody>
</table>
Codes are tags or labels that assign meaning to sections of text that were recorded and transcribed during a study (Miles and Huberman, 1994). These codes are used to label and categorise the text in order to aid analysis, identify themes and help build a theory (Gibbs, 2007). Figure 3.6 shows diagrammatically how codes are built into categories, themes and theory.

![Figure 3.6: Codes-to-Theory Model for Qualitative Analysis (Saldaña, 2009, p.12)](image)

In general, this is referred to as Coding and Clustering. Coding is deriving and developing concepts from data. Clustering is the grouping of these data threads (Corbin and Strauss, 2008). However, despite having this outline, it can only provide loose guidance during the analysis process which almost invariably evolves as the data begins to reveal its meaning (Dey, 1993). Rather than being linear, a more contoured process must be employed as shown in Figure 3.7. The data analysis spiral includes all the necessary stages in the interpretation of the material but also shows the somewhat iterative nature of the process.
This constant comparison is essential because the understanding of the researcher develops during the analysis process. Initially, some themes have to be established, but they are likely to evolve having been necessarily based upon a small proportion of the data. As more information is evaluated the codes become more refined, but without monitoring the earlier decisions, these categories may no longer accurately match the data associated with them.

### 3.7.5 Coding Technique

The coding process was carried out using Computer Assisted Qualitative Data Analysis Software (CAQDAS) called NVivo (QSR, 2014). This technology did not alter the theoretical technique used to code the transcript data; it merely facilitated the process. However, the ability to easily review and restructure codes was particularly useful given that the procedure, as described by Miles and Huberman (1994), required successive operations in order to refine the codes progressively.

Table 3.17 describes the thematic analysis process that was followed. The initial phase was familiarisation with the data, which included reading notes taken at the time of the interview, reviewing the audio recordings, and editing out unnecessary sections such as the exchange of pleasantries at the beginning and end of interviews. Having
rechecked the audio, it was sent to be transcribed by a third party. Once the interviews were transcribed, they could be directly imported into NVivo. The next step was to start generating the initials codes. This was done by identifying themes in the text, highlighting them as is shown in Figure 3.8, and creating a word or phrase to describe the theme. Using the NVivo software allowed each code to be named and have an associated description attached to it digitally. This enabled much more detail to be associated with a code than would have been possible with a manual analysis process. This level of details is also useful when returning to codes, and precisely verifying what the theme was.

Figure 3.8: Example of Coded Interview

Over time a system of descriptive codes was developed, with the codes summarising the topic described in the relevant section of the transcript (Miles and Huberman, 1994). This technique is also known as Topic Coding (Saldaña, 2009). As more codes were created, it was possible to see relationships between them building into categories and themes, which the NVivo software allowed to be organised into a hierarchy or tree structure (Bazeley, 2007), as shown in Figure 3.9.
Figure 3.9: Example of Hierarchical Coding System

As the number of codes grew, it was necessary to go through a number of rationalisation techniques. On one level this was necessary to check whether any additional codes had been created, as it can be quite easy to create a new code when an existing code would have sufficed. The software made it very easy to reallocate text to the appropriate existing code. Using the organisational abilities of the software not only helped improve understanding of the data but also facilitated its Splitting and Splicing (Dey, 1993). The splitting of codes into subcategories can happen quite naturally during the initial coding process, but this needs to be refined once the first cycle of analysis is complete. Having finished the first iteration, it was necessary to re-evaluate categories based on the new perspective provided by the now more global
view of the data. The splitting was followed by splicing, which took data that had been previously broken down and combined it to form more coherent groupings. This assemblage of similar strands produced fewer, but more decisive, categories which supported the analysis process (Dey, 1993). The list of codes and their hierarchy created at this point can be seen in Appendix L.

3.7.5.1 Resource Evaluation Process Analysis

The data for the evaluation of the d.eco website was collected as described in Section 3.7.3. The questionnaire produced written answers to the five main questions asked. SurveyMonkey allowed the data to be exported as a text document that could be imported into NVivo. Given the similarity to interview responses, as discussed in Section 3.6.2, the questionnaire responses were coded in the same way as the main study as described above. There was less data collected in this process than in the main study, so manual splitting and splicing was sufficient to identify the relevant categories for analysis. The following section describes the process required to cluster the 277 codes generated as part of the main study.

3.7.6 Clustering Technique

Clustering is the process of inductively creating categories and sorting things into these categories (Miles and Huberman, 1994). The process described in Section 3.7.5 achieved this and created 277 codes with the following nine overarching clusters:

- Brief
- Briefing Process
- Company Ethos
- Design Process
- EcoDesign
- Information Matters
- Information Sources
- Legislation
- Solutions

277 codes is a large number to be certain of how comprehensive the splitting and splicing process had been. Where it was comparatively straightforward to see relationships between codes, these were captured, but it is possible that there were less obvious connections that may have been missed. To investigate the analysis process further, a Clustering Matrix (Kumar, 2013) was used.
A Clustering Matrix is a visual method for clustering data that can also utilise algorithmic software for sorting larger data sets. Codes found using NVivo were listed, scored against each other, and sorted to reveal clustered patterns as dark-coloured patches (Kumar and Whitney, 2007). The steps described in Table 3.18 were followed to create a matrix in Excel (2010). This was a fairly straightforward process, but time-consuming with so many codes.

Table 3.18: Steps in Creating a Clustered Matrix (Adapted from Kumar, 2013, pp.159-160)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description of the Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>List entities for clustering</td>
<td>List the kind of entities you want to compare to one another to find clustering patterns</td>
</tr>
<tr>
<td>Determine the relation between entities</td>
<td>One most commonly used relation is similarity that measures how one entity in the list is similar to another</td>
</tr>
<tr>
<td>Determine a scoring scale to measure relations between entities</td>
<td>The most commonly used scale has four steps: 0 means no relation between entities, 1 means minimum relation, 2 means medium relation, and 3 means maximum relation. It is a good idea to colour-code matrix cells according to the corresponding scores</td>
</tr>
<tr>
<td>Create a symmetric matrix</td>
<td>Create a spreadsheet with a square symmetric matrix. For this, enter the same list of entities as both row and column headings. Each cell in this matrix represents a relation between two corresponding entities</td>
</tr>
<tr>
<td>Score the relations</td>
<td>Enter a relation score in each matrix cell. Scoring activity can be time-consuming and may need to be split up as the size of the matrix increases</td>
</tr>
<tr>
<td>Sort the matrix</td>
<td>For small matrices (up to 30 x 30), you can do a manual sort of the matrix by shifting the position of columns and rows in the matrix so that two rows or columns having similar scores are kept next to each other. For larger matrices (more than 30 x 30) it is better to use available statistical algorithms to sort the matrix for efficiency</td>
</tr>
<tr>
<td>Identify clusters</td>
<td>After sorting the matrix, take a step back and look at the whole matrix and see how many entity clusters can be visually identified. In a symmetric matrix, clusters are going to form along the diagonal of the matrix</td>
</tr>
</tbody>
</table>

A Clustering Matrix is symmetrical, so the code in row one matched the code in column one, the code in row two matched the code in column two, and so on until the code in
row 277 matched the code in column 277. The codes were taken directly from NVivo and put in the same order that can be seen in Appendix L. This started with the subset of Bad Briefs: Complicated Briefs; Don’t Know What They Want; Engineering Brief; Hierarchical Company; Managing Director; Marketing Driven; Not Designers - No Problem Identified; Passed Around; Stolen; Time too Short; Written for Boss. A small section of the matrix can be seen in Figure 3.10.

<table>
<thead>
<tr>
<th></th>
<th>Complicated Briefs</th>
<th>Don’t Know What They Want</th>
<th>Engineering Brief</th>
<th>Hierarchical Company</th>
<th>Managing Director</th>
<th>Marketing or R&amp;D Driven</th>
<th>Not Designers - No Problem Identified</th>
<th>Stolen</th>
<th>Written for Boss</th>
<th>Company Champion</th>
<th>Debrief</th>
<th>Educated Client - Design Manager</th>
<th>Clients Not Designers</th>
<th>Competition or Funding Bid</th>
<th>Cost and Time Restricted</th>
<th>Customer Generated</th>
<th>Design Input Required</th>
<th>Eco Brief</th>
<th>Eco Marketing</th>
<th>Eco Stealth</th>
<th>Following Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated Briefs</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Don’t Know What They Want</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Engineering Brief</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hierarchical Company</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Managing Director</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
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<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marketing or R&amp;D Driven</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Not Designers - No Problem Identified</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
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Figure 3.10: Close Up of Initial Scoring of Clustering Matrix

Once all the codes were listed against each other, they were scored using the scheme suggested by Kumar (2013) a zero (0) meant no relationship between entities, one (1) meant minimum relationship, two (2) meant medium relationship, and three (3) meant maximum relationship. Given that the matrix was symmetrical the number 3 must be all along the diagonal because whenever the codes are against each other, there must be a maximum relationship. The Conditional Formatting function was used in Excel (2010)
which allowed the numbers in the matrix to be represented by colours which increased with darkness the closer the relationship between codes. Using colours made it much easier to identify clusters than would have been possible just using numbers, especially with such a large matrix. This process of ranking the relationship between codes was repeated for the whole 277x277 matrix. As suggested by Kumar (2013) the scoring activity was very time-consuming, and so the matrix was split into four sections and scored over several days. The completed scoring of the whole matrix can be seen in Figure 3.11. This image shows the whole matrix and is too small to read individual codes but does reveal cluster patterns as well as giving an impression of the scale of the matrix. It was possible to see some clustering at this initial phase, which was created by the splitting and splicing process described in Section 3.7.5. A close-up view of the matrix divided into smaller sections can be seen in Appendix N.

Figure 3.11: Completed Scoring of Clustering Matrix
This matrix could have been visually sorted manually by shifting the position of columns and rows in the matrix so that two rows or columns having similar scores are kept next to each other. However, as suggested in Table 3.18, to sort such a large matrix, it was better to use statistical algorithms. Unfortunately, none of the literature published by Vijay Kumar or his collaborators gave details on how this might be done. However direct contact with them provided details of the statistical algorithms or software which could be used (Erwin, 2014; Schoppe, 2014a). The Clustering Matrix is a type of Cluster Heat Map which is widely used by the biological sciences (Wickert and Lewis, 2013). Due to this similarity, (Schoppe, 2014a) recommend using Cluster 3.0 (de Hoon, 2002) which was developed for sorting gene sequences. Full details of the mathematics, as described by Schoppe (2010), can be found in Appendix M. Having converted the data in Figure 3.11 into a tab-delimited text file it was loaded into Cluster 3.0. Following instructions from Schoppe (2014a), the software was used to perform hierarchical clustering with the Euclidean distance metric setting. There are four clustering methods that could have been used: Single Link, Complete Link, Average Link and Centroid Link, as explained in Appendix M. Having processed the data using all four clustering methods, and visually checking the results, the Average Link clustering method was found to produce the best results. This data was then returned to Excel (2010) where the colour coded conditional formatting could be re-applied. Having completed the process, a description of the procedure was sent and verified as correct by Schoppe (2014b). Figure 3.12 shows the result of the clustering process.
On a computer screen, the full matrix was too small to be seen properly, so it was printed out onto fifteen sheets of A3 paper to help with analysis, see Figure 3.13. A close-up view of the matrix divided into sections can be seen in Appendix N.
Figure 3.13: Photograph of Sorted Clustering Matrix

As shown in this image the clusters were moved toward the top left and bottom right corners of the matrix. This meant that the centre of the matrix no longer had any significant clusters and could be removed to simplify the diagram.

The areas where no significant clusters were found were removed, creating a smaller 145x145 matrix. This smaller was much easier to read, enabling visual sorting and a few rows and columns were reordered to produce a neater matrix. From this process, four clear cluster groups were found as can be seen in Figure 3.14. A close-up view of the matrix divided into the four sections can be seen in Appendix O. The following list gives the four cluster groups:

- Brief and Briefing Process Cluster
- EcoDesign and Company Ethos Cluster
- Information Matters and Sources Cluster
- Legislation and Solutions Cluster
In essence, the matrix based clustering process removed codes that existed in isolation, or with little connection with other codes, and independently created its own clusters. These four new clusters resembled the nine created in the splitting and splicing process but amalgamated codes across clusters. As is shown in Table 3.19 the clusters created by the Clustering Matrix method found connections between what were separate clusters when identified manually. Also, there is no Design Process cluster in the Simplified Cluster Matrix. This is because the Design Process codes fell in the central blank area, see Figure 3.12, of the algorithmically clustered matrix.
Table 3.19: Comparison of Results from Splitting and Splicing with Clustering Matrix

<table>
<thead>
<tr>
<th>Clustering Matrix Clusters</th>
<th>Splitting and Splicing Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brief and Briefing Process</td>
<td>Brief</td>
</tr>
<tr>
<td></td>
<td>Briefing Process</td>
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<td></td>
<td>Design Process</td>
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<tr>
<td>EcoDesign and Company Ethos</td>
<td>EcoDesign</td>
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<td></td>
<td>Company Ethos</td>
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<td>Information Matters and Sources</td>
<td>Information Matters</td>
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<td>Information Sources</td>
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<tr>
<td>Legislation and Solutions</td>
<td>Legislation</td>
</tr>
<tr>
<td></td>
<td>Solutions</td>
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</tbody>
</table>

While the Clustering Matrix process helped simplify the list of NVivo codes, and did much to corroborate the manual clustering process, it was still applied to qualitative data. This meant that there remained potentially useful data contained in the removed codes, especially those that related to Design Process. Clustering Matrices, although very helpful, still required the knowledge and judgement of the researcher to interpret them correctly.

3.8 Research Reliability and Validity

When designing a research project, it is important that the findings be accurate and credible. This can be harder to establish in flexible qualitative research than in quantitative studies (Robson, 2002). Given that a level of interpretation is always necessary in qualitative research (Flick, 2009) the aim is to minimise the possibility of inaccuracies rather than reaching the level of repeatability and generalizability that might be expected in a quantitative study (Saunders et al., 2009). To demonstrate rigour in qualitative design and data collection, the issues of reliability and validity need to be considered.

3.8.1 Research Reliability

Reliability is the extent to which data collection techniques and analysis procedures yield consistent findings. A reliable observation is one that could have been made by
another similarly situated researcher (Flick, 2009). According to Saunders et al. (2009, p.156), reliability can be assessed by posing the following three questions:

- Will the measures yield the same results on other occasions?
- Will similar observations be reached by other observers?
- Is there transparency in how sense was made from the raw data?

It is hard to say whether the research would have yielded the same results if conducted on another occasion, as this would be partially dependent upon the participants. However, there are aspects of the process that were able to be controlled by the researcher. Through the maintenance of a systematic and consistent research procedure, any variance in the interview studies was minimised. This was less of an issue with the questionnaire survey where all participants viewed identical online surveys, so reducing the direct influence of the researcher when answering questions (Sommer and Sommer, 1997).

In the context of doctoral research, it is not possible to have data collected and analysed by a team of researchers, which would have been a standard way of minimising observation bias (Denscombe, 2007). However, the data was collected in a consistent way, and there was an audit trail that includes records of all participants; when studies were conducted; associated ethical documentation; notes taken during studies; audio recordings of interviews and transcriptions of those recordings.

The preceding sections of this chapter discuss in detail the process of data analysis. Records have been kept at all stages of the analysis process, including NVivo and Excel files that show the coding and clustering process. The Clustering Matrix was used in part to minimise any biases in the analysis process.

### 3.8.2 Research Validity

Validity considers whether the indicator that is devised to measure a concept really measures that concept (Bryman, 2008) or whether the researcher sees what they think they see (Flick, 2009). Robson (2002) describes there being three main types of threat to validity which are Description, Interpretation and Theory. An explanation of these threats can be seen in Table 3.20.
Table 3.20: Threats to Validity in Flexible Designs (Adapted from Robson, 2002, pp.171-172)

<table>
<thead>
<tr>
<th>Type</th>
<th>Explanation</th>
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</thead>
<tbody>
<tr>
<td>Description</td>
<td>The main threat to providing a valid description of what you have seen or heard lies in the inaccuracy or incompleteness of the data. This suggests that audio- or video-taping should be carried out wherever feasible. Where taping is not feasible, the quality of your notes is very important</td>
</tr>
<tr>
<td>Interpretation</td>
<td>The main threat to providing a valid interpretation is that of imposing a framework or meaning on what is happening rather than this occurring or emerging from what you learn during your involvement with the setting. This does not preclude a style of research where you do start with some kind of prior framework, but this must be subjected to checking on its appropriateness</td>
</tr>
<tr>
<td>Theory</td>
<td>The main threat is in not considering alternative explanations or understandings of the phenomena you are studying. This can be countered by actively seeking data which are not consonant with your theory</td>
</tr>
</tbody>
</table>

Description issues are dependent upon the accuracy and completeness of data collected. As Robson (2002) suggests, all data were collected digitally online or using an audio recording device, and notes were also taken. Interpretation issues relate to the way in which data was analysed and interpreted, this process was grounded in the data, and one reason that 277 codes were produced was that all aspects of the interview were considered, rather than just coding sections that fit within an existing framework. Theory issues are harder to account for directly in the interpretation of the data, but this is why there was a resource evaluation process. The d.eco website was created to check whether the theory developed from the main study was valid. Furthermore, the theory was created in the context of the Literature Review, creating data triangulation between the three methods of data collection (Denscombe, 2007).

3.9 Summary

This chapter describes in detail and justifies the overarching strategy used to conduct the research as well as the individual research methods and analysis techniques that were used. The process described was applied to the collected data and resulted in some key findings. These findings are discussed and applied in the following chapters.
4. STUDY OF SMALL DESIGN CONSULTANCIES

This chapter presents the findings of the Pilot Study and Main Study, which were conducted using in-depth interviews. The Pilot Study was used to refine the interview questions, with the aim of answering relevant research questions, to better understand the way in which Small Design Consultancies manage and implement their design projects.

4.1 Introduction

In order to best answer the research questions a number of in-depth interviews were administered. Initially, a pilot study was conducted so that the interview questions could be checked and refined. The pilot study consisted of five interviews with five designers from five different Small Design Consultancies, full details are given in Section 3.7.2.1 and Appendix F. This was followed by the main study which was composed of 20 designers and one design researcher from 18 different consultancies. In total 26 participants were recruited from 22 different SDCs. The participants had an average (and median) of ten years’ experience, which ranged from two to thirty years. The main study involved designers working in SDCs based in London, South England, the Midlands and Wales. The majority of the consultancies visited were in London and South England, this is also where the majority of design businesses working in product and industrial design are based (Design Council, 2015, p.53). Sixty percent of the companies visited had up to eight employees, and the rest had 30-50 employees. Again this proportion is not unreasonable as most design consultancies in the UK employ fewer than ten staff (Exon and Cox, 2010, p.4). A list of the questions used in the main study can be found in Appendix H.

4.2 Data Collection

Full details on the data collection process are described in Section 3.7.2, on the interview process. The pilot study helped to clarify the interview questions, which included: understanding the product design process (PDP) that designers in SDCs actually use; finding out how much influence designers have over their briefs; discovering how designers learn and share their knowledge within their company and what level of knowledge and experience SDCs have of EcoDesign principles. The five main interview questions were:
Chapter 4 | Study of Small Design Consultancies

> How does your company work?
> What is the company product design process (PDP)?
> How does the company learn?
> What does EcoDesign mean to you?
> What do you know about Eco Laws?

Each of these questions was subdivided into further questions giving an additional 20 questions that could be used to help clarify or expand the responses given to the main questions. Full details can be seen in Appendix H.

4.3 Results

The interviews resulted in more than 200 pages of transcribed data. Two example transcripts can be found in Appendix K. The results presented below have been clustered into the key themes that were identified by the analysis of the interviews. These follow the groupings shown in Table 3.19 but are subdivided to provide extra detail.

4.3.1 Design Brief

The brief is a very important part of the design process. It defines the scope of the project and the necessary elements it must contain. There was a surprisingly large range in the type and length of briefs that designers received. These differences were mainly due to the kind of client, the market the final product was destined for and the maturity of the product or product range. In heavily regulated areas such as medicine or transport, there are tight restrictions on the materials and technologies that are acceptable, and this was usually reflected in a very specific and lengthy brief, or accompanying specification sheets. Similarly, with products that have already been manufactured for many years, and the client is looking to update or an addition to the product range, detailed knowledge already exists about their market, pricing points and technologies. Briefs for these ‘mature’ products were more of an idea attached to a specification sheet and included a significant amount of technical data. However, despite having so much information, this type of client does not “necessarily know what they want in terms of design until they see or hear it” (DesG-m). Briefs can be equally
well defined when an individual entrepreneur or inventor has developed a concept that is technically sound and well-funded but just needs an SDC to make the design market ready. The other end of the brief spectrum is the “ultra-minimal, ‘Italian style’ brief, which can be as short as the word, soft” (DesE-p) or just supplying the SDC with some “Lego as inspiration” (DesA-p) for a product. However, this type of brief generally forms part of a discussion rather than just a briefing document. This was usually because the client company only has a very superficial idea of what they wanted to achieve, and the SDCs were there to distil this idea in order to define a need and translate this into a proposal or brief. Another reason for short briefs is that it can take a significant amount of time and effort to put together a very detailed brief. Smaller clients might want to avoid this, particularly if they already have a relationship with an SDC, and trust their judgement.

Much of the discussion was around badly written briefs, which could mean getting very detailed without properly establishing the need that the product is trying to address.

“We have rarely been given good briefs by clients. Our briefs can be ridiculously detailed, and you find when you unpick it that loads of stuff is quite arbitrary, but it has the veneer of technical detail. You make a few phone calls to the client and start realising the detail is based on really shaky foundations.” (DesG-m)

Bad briefs were often written in isolation by lower level employees, managers, or by the marketing department rather than designers. They were often actually written for line managers, to reflect the amount of work that had been done, and were likely to be long, just to look substantial.

“Customers are absolutely shocking at setting design briefs, particularly marketing departments are awful. The marketing department usually consists of a young product manager – that’s not a barrier to having knowledge, but they’re usually inexperienced – 99% of the time, they aren’t comfortable with commissioning design in any way because it could all go horribly wrong. So they’re really nervous of it. And they don’t understand how to prioritise the issues which you need to get a design brief.” (DesO-m)
Even when a brief has been well specified, there may be levels of importance attached to different aspects of the product, and ultimately a compromise between designer and client is found.

“There might be statements about the product like it must contain XYZ with a column saying the level of that. So, is it ‘ideal’ or is it a ‘want’ or is it ‘must’? So there is a little bit of toing and froing, it’s about reaching a compromise.” (Desl-m)

Another type of brief was referred to as the ‘me too’ brief. These are briefs where the client sees competitor products and feels the need to create a rival offering.

“A client would sort of say, ‘Well, you know, the competitor has got this product, and we’re losing market share.’ You know, they’ve got one and we want one too – me too type stuff. And so, you know, they never identify an actual design problem.” (DesO-m)

This is another area where marketing departments rather than designers often led the briefing process, which resulted in insufficient vision.

“Sometimes I think, while not wishing to be too damning, I don’t think they particularly have any vision beyond sort of copying what other companies are doing.” (DesL-m)

Whilst the interviewees spent more time speaking about bad briefs, and the limitations of their clients, there was also discussion about good briefs and enjoyable briefing processes. However, most of these examples were when the client involved their own design team in the briefing process.

“So in some cases, it is design teams that we are talking to, especially if they are big enough to have their own design departments. We’ll be talking directly with the design department, and people that know about design to an intimate level, making the process much easier.” (DesV-m)
Some of the larger SDCs were asked to do ‘trend analysis’ by clients to understand better the needs and desires of future consumers, what technology may be available and popular, as well as predicting market performance.

“They just come and say they want to know the future of white goods for the next ten years. And then we do trend analysis that’s going and looking at what does food mean to people. Rather than saying what are fridges going to be like, it’ll be really broad like what’s food and what is the culture in this country. It might be comparing the UK to Spain or something, and what a fridge is historically in Spain versus the UK, so it’s really quite exploratory.” (DesI-m)

This type of very open brief was likely to come from large clients with their own in-house design teams. This was partly because they are the most common group to have the budget for this type of speculative exploration, but also have issues with group-think. When there are groups working in a very focused area, it can be useful to have outsiders disrupt and stimulate new ways of thinking.

“A company might come to us and ask us to look at the future of telecoms. We will design concepts and ideas and ecosystems around that, and they will take that and build upon it. You know, they’ve got enough designers, as do most consumer electronic and manufacturers have, they have a lot of in-house designers that work in such a narrow bandwidth. They are not necessarily being massively creative because they are stifled, you know? They do the same thing day in and day out. They will come to us for an outside opinion, I suppose, a bit of turbulence if you can call it that. So we’ve been, I suppose, creating turbulence for twenty-five years.” (DesV-m)

SDCs also generate their own briefs, this kind of speculative work is much freer flowing and can be developed informally over an extended period. There was no guarantee that any money would be made from these projects, but they served to extend the portfolio of an SDC and showcased their work.
“If we have an idea, about a quarter of the time we come up with something which a company wants to do and 75 percent of the time they say something like, ‘Ooh, that’s an interesting approach. Based on that approach, how about if you do this other product for us?’ It’s a way of getting work, it gives potential clients an insight into how you work.” (DesG-m)

What was clear in discussing briefs is that there is a lot of variety in how briefs are received and developed. Except for a few exceptions like ‘mature’ or ‘regulated’ briefs, see page 100, the SDCs interviewed agreed that good briefs were drawn up in collaboration with their clients. This process is discussed further in the following section.

4.3.2 Briefing Process

As was made clear in the previous section, there are many pitfalls that clients can fall into when writing briefs. To deal with this problem, many of the interviewees spoke of a collaborative briefing process. So, rather than the traditional top-down approach, clients met with an SDC, explained the problem they are trying to solve, and the designers attempted to express this in a written form. This document would then passed backwards and forwards until the SDC, and the client agreed on what the essence of the problem was.

“I think that I receive brief in the form of probably a brief chat. I never ever get a formal written brief. The client will throw something at me. I will go away and think about it, consider it, set up some of the kind of ground rules. And, that will be agreed and it will develop as we go along, you know, iteratively, interactively.” (DesM-m)

“So the client comes in for a free meeting to explain what their problem is, then we start to build an understanding which we write down, so we write down what we think their problem is. Then it goes back to the board until we agree on what the essence of the problem is and then we hit them with the proposal. We also send them a long questionnaire and it just kind of impresses upon them what they know, what they don’t know, and what gaps in the brief are yet to be filled.” (DesH-m)
“We’d have a meeting to understand, to talk around the problem, try and extract information from them. The result of that would be we would write back to them with an outline specification, a design brief, of what we thought it was we were designing.” (DesO-m)

This means that the SDCs have quite a lot of control over their briefs, rather than it just being driven by the client.

“We’ve been able to put a lot of influence in terms of setting the brief and where they should go as a whole. Right at the beginning with the projects, we do get to influence the brief and the spec, the way it should go.” (DesN-m)

“We do have a lot of influence. I guess most of the time the client just wants something, don’t know how to get it, and when we said the ways to pursue it, they usually agree. I mean most of the time clients are quite agreeable.” (DesS-m)

This influence can be particularly powerful if the SDC or its directors have a celebrated reputation, and clients have come specifically for that kind of input.

“They gave us the brief for a series of washing machines, and the director just fired it back… basically changed the wholebrief in front of them, and they were happy for that.” (DesV-m)

“I mean it’s not uncommon for us to get some sort of briefing where somebody thinks they want a particular product and you work on it for a month or two, pitch it back to them, you do your presentation, and they realise that it wasn’t what they thought they wanted.” (DesG-m)

An additional advantage of this process is that there can be more buy-in from the client. Rather than a brief being the creation of one person, it has evolved from a team of people from both client and SDC.
“Initially companies have ideas in space, which are digested into a proposal. You usually notice lots of nodding, smiles, or their eyes sparkle when the right ideas are being discussed.” (DesG-m)

“The great thing about having a discussion is that you sort of form the brief and the ideas together. The client is there, the client has got the buy-in, ideas are conceived there and then. You’ve got the client on board, they come with you. It’s not your idea; it’s their idea as well. It’s a really good way to have a relationship with a client. It’s their baby, they’ve got a vested interest in it. They like to think they have designed it. They haven’t really; they’ve just had an input.” (DesV-m)

It would seem that briefs that work best for both SDC and client are ones where both parties feel they have had a significant influence over the final, agreed brief. It is more of a partnership than a traditional hierarchical relationship.

4.3.3 Design Process

None of the designers interviewed followed a formal, product design process, but it was clear that their experience had led to an effective model for design. The lack of a written PDP, which they actually adhered to, meant that the designers could only describe their process in very general terms. Despite the differences in the way, designers described their PDPs, at a macro level they were quite consistent. In essence, they fit with the Design Council (2007a) model ‘Discover – Define – Develop – Deliver’ or other models that use a similar set of basic steps, see Section 2.5.1.

“So it’s sort of like a linear process, but there’s always loops that come back. It’s great if you can allow things to float for a while and if you basically have a resistance in a sense, to things being too complicated or at least, let them get complicated but keep trying to filter that down. So it’s not just looping, it’s more like expansion and contraction.” (DesG-m)
The fundamental differences in projects seemed to stem from their design brief or definition of the need that they were trying to address.

“It varies enormously on each project, but we have been implementing a process. So what happens now is there’s lots of where we want to take it, like mood boards, theme boards, standard design things I suppose. Then straight from that, concepts, just as many sketches and ideas on paper as possible. Then from there we kind of narrow down to three concepts.” (DesH-m)

An additional complication highlighted by several interviewees was that the design process does not necessarily stop once they have delivered their design. Large companies with their own design and manufacture teams, as described in Section 4.3.1, often make their own modifications to the design.

“The LG, Sony, Samsung, Panasonics of the world will have their actual making rooms or their own infrastructure to do it. So, a lot of the time you are handing back surface data which will then be manipulated. This is why it’s difficult to get a sustainable issue on this because they take it out of your hands pretty quickly and do what they want with it.” (DesV-m)

4.3.4 EcoDesign and Company Ethos

A number of the interviewees expressed that their values influence their approach to design. Many expressed their concerns about the environment, but also more generally about an ethical design approach.

“I suppose trying to do things which are of benefit to other people within society. Those are the things which have interested me, and I think we’ve got some other examples. The principle of trying to do something that benefits people is kind of interesting.” (DesG-m)

“The business plan we started out with was actually sustainable and inclusive methodologies that apply to the mainstream design. Also, the kind designers
we were interested in being around were really designer-makers, and they had the strong ethics and interest in sustainability.” (DesH-m)

“We’re not claiming to be experts in environmental design, we’re saying that we try and design efficiently, make our products last longer, use the minimum material required, follow the WEEE directive. It isn’t enough, but that’s what we can do at the moment I think.” (DesO-m)

“Most of our self-generated projects are driven by some sort of ecological problem, so that’s kind of where our eco-design ethos starts. It’s not that we just sit and design a chair, and then it’s like oh let’s try to make it with more sustainable material.” (DesS-m)

While those working in SDCs may have their own principles; clients have specific cost requirements which relate to the market they have built their business plans around. Unless it is a specific requirement of the client, EcoDesign either has to be included without affecting the viability of the final product in its market, or a strong case has to be presented to the client at the briefing stage. There is unlikely to be any change in the very specific and lengthy briefs referred to in Section 4.3.1.

“Clients are only interested in being green if it doesn’t cost them any more money. If the SDC is really into it, that’s fine as long as the product still hits the price point. Though, they probably wouldn’t publicise it, in case it’s a can of worms. If they didn’t commission a green product, hadn’t built a marketing story around it, their customers might ask difficult questions about other products.” (DesG-m)

Clearly, there are some projects where sustainability forms a major part of the brief, but these are generally created for a specific market where a premium is paid for the eco-credentials of the product. The ultimate aim would be to have sustainability considered alongside other design criteria and with a similar weight. Briefs rarely allow for this, but some designers do indulge in ‘eco-stealth’.
“Sustainability tends to be included in products either by stealth, or it actually gives them some kind of sales leverage. It’s very rare for briefs to be a completely altruistically.” (DesF-p)

However, if there is a champion within the client company, particularly if they hold a senior position, their influence can supersede the bottom-line.

“I think also you need to have someone in the company who really believes in it. I mean sometimes you’ve got eco-warriors inside the companies, I mean they call themselves that kind of almost sheepishly in a meeting they kinda go, ‘Well I’m a bit of an eco-warrior’ just as a self-deprecating way of bringing up the topic because they know they’re going to get a bit of banter about it.” (DesG-m)

Ultimately only a few of the briefs tackled by the interviewees had a strong EcoDesign element, though this did not stop some of them considering the environmental impact of their work. There was a tendency for the designers not to describe their work as EcoDesign, even if they considered sustainability as part of their design process. The approach that most designers described was Design for Durability, though they did not use this terminology. There were also elements of Design for Disassembly, and a readiness to try and select materials sensitively.

“I don’t really like the word EcoDesign very much. I think if EcoDesign is the driving factor then you probably won’t end up with a great product. Designers are becoming much better at this now because there’s so much more awareness, you’re generally thinking eco about everything, so thinking about material usage, where it’s coming from, packaging, all those kinds of things.” (DesK-m)

The interviewees also talked about EcoDesign just being an element of good design, something that should be considered in any design like cost, materials, manufacturing or user experience.
“I think most environmental design practice is just kind of good design behaviour. For me, it’s just part of good design. For me, it makes it more interesting. It’s still the same design challenges but with an extra layer of complexity.” (DesT-m)

4.3.4.1 Opposition to EcoDesign
While many of the interviewees either practised or aspired to EcoDesign principles, there were also those who either disliked the terminology or EcoDesign in general.

“I see a lot of EcoDesign, and it looks f-ing awful. I feel really bad saying this; you find a lot of designers like to make stuff and do stuff with it, and it’s not very good. I think maybe is it an excuse for people who aren’t particularly good designers; it’s a new angle for them to start making chairs out of old razor blades.” (DesV-m)

“I don’t dislike EcoDesign, but what probably annoys me is when somebody says I’m going to design an eco-product, necessarily a driving factor because it can be put into absolutely everything and it should be, and any reasonable designer should be doing that.” (DesK-m)

“Well, I guess that I kind of take issue with the concept of EcoDesign. I would just refer to it as design because I feel like being responsible means making choices that are well informed on everything. I take issue with the term EcoDesign as it turns it into a fad. I think I do prefer ‘efficiency’ because it’s like … because it doesn’t stigmatise it.” (DesQ-m)

However, most of the negative comments could be considered to come from the same standpoint. i.e. EcoDesign should not be considered in isolation, but more widely as part of the design process. When this is not done the resulting design is poor because it neglects other important aspects of design. Unfortunately, many of the examples touted as EcoDesign suffer from this.
4.3.4.2 Complexity in EcoDesign

The majority of participants did not have great experience of doing EcoDesign projects, but those that did were very aware that it can be very complex to create a product that has a net environmental benefit compared with its competitors.

“And it is definitely a growing area, but it’s hugely complicated. If you were to do the life cycle analysis of your tape recorder you’re looking at a huge bill of materials within that. Every single one of those has a different impact and then its impact on energy use, water use, natural resources. There’s so many different things that you can judge it on and it’s becoming identified but we need to start looking at this.” (DesX-m)

DesW-m and DesX-m discussed these issues at much greater length; the full transcripts can be seen in Appendix K. They described projects and listed many of the issues that need to be considered when trying to minimise the impact of a product.

“And some of it is quite counter-intuitive as well. I think that’s the other issue that it’s not all common sense. Some of it is but there’s some weird scenarios in which one thing that seems inefficient might actually be more efficient, and then you get into these arguments of how do you know what’s efficient? It’s very difficult.” (DesQ-m)

“Life cycle assessment, that phrase makes it sound very simple, but the reality is that when you start trying to look at the whole life cycle of a product, it immediately gets extremely complicated. So are you looking at energy usage or are you looking at carbon footprint? Are you looking at things like land usage? How many of these various things are you taking into account? But, yeah, there are ways of simplifying it. Narrowing it down to carbon footprint, I think in a lot of case is a very valid approach for a designer.” (DesL-m)

Unravelling the complexity is not made easy for designers because their suppliers cannot necessarily answer all the questions they would need to analyse their designs fully.
“A lot the suppliers can’t answer the questions necessarily completely straight. So we have to kind of get the information from them and then make the calculation ourselves.” (DesY-m)

There was also some trepidation that EcoDesign is such a complex issue that designers do not have the necessary knowledge to complete a project properly.

“It seems like more and more there are people who are coming out with models that really easy to implement – that’s the thing that scares me – I would be able to like use it within the design process, and I’ve heard that there’s more and more ways you can chunk it up and like just have practical ways to design it in an eco-way that’s like counting the kilo-joules that are being put into the manufacturing of the product and calculating how much it’s consuming and the usage. Because otherwise it seems overwhelming to me and I don’t think I can understand.” (DesZ-m)

The Designers were also worried that they could not confidently sell EcoDesign to their clients.

“It’s a very difficult thing to sell right now because unless the client is specifically interested in it which generally they’re not, it’s quite difficult for us to say, “You should definitely do this.” And also we can’t confidently say that we can do it either because it is a hugely complicated process to do, but that’s not to say we couldn’t do it because there are more and more websites around and consultancies around where you can.” (DesX-m)

However, it is good that these designers are aware that there are so many aspects that need to be considered as part of EcoDesign. They also highlighted that this is something that needs to be taken into account from the start of the design process, rather than tacked on the end.
“To have any impact EcoDesign needs to be at the start of the design process – taking a kind of design product and mitigating its damage is maybe you’ll make a bit of difference but it’s not a lot. If you are wanting decent impact, then it’s definitely at the start. It’s not always possible that you can do that, but that’s definitely where it should happen.” (DesT-m)

The lack of confidence when trying to make claims about the environmental impact of products could be seen a positive characteristic of the interviewees. It shows that they understand enough to know that it can be a very complex issue, and have the integrity not make claims they cannot substantiate. This links back to Section 4.3.4, page 108, where designers talked about their personal ethics around EcoDesign, their desire to minimise the impact of their designs, but their reluctance to label their work EcoDesign.

4.3.4.3 Consumer Behaviour

There was an acute awareness of the role the consumer plays, and the designers interviewed were honest about their own actions when they use products in their daily lives. This was picked up in particular where energy in-use was the biggest impact of the product.

“There are one-cup solutions like this is one, what it does do is it creates awareness of the issue of boiling an amount of water. I think the education comes first and I think actually a thing like these one cup things is actually educating people in a sense. Otherwise, someone can buy a green kettle, think they’re being really environmental and keep boiling up a litre every time they need twenty-five centilitres and um that’s crazy.” (DesG-m)

“Boots did analysis on their packaging for the shampoo, and they saw that was the breakdown in terms of the production distribution materials, but then they did another analysis where they included the hot water. Doing this you can see how little effect the packaging has. So they then went and said, ‘Well we’ll reduce the carbon footprint of our shampoo but can you help too by using cooler water...’ and not spending as long in the shower. So I think that’s really interesting from a design point of view because we’re interested
obviously in users and the design aspect. You totally get focused on eco
materials. To me is key isn’t focussing just on the materials or the product, but
to focus on the entire system. So it’s users plus system.” (Desl-m)

This impact of product longevity was also highlighted, and how this can depend on the
user as well as the designer.

“Once a product has gone out – you don’t know when it’s going to be used,
so there’s no deadline attached to it. It could be two years because
somebody’s got bored of it and want a different colour. It could be a day
because they don’t like it. It could be 15 years because they love it and it’s
just – a cow sat on it or something!” (DesK-m)

“You know people keep i-Macs for absolutely donkey’s years even when they
are performing really badly compared to a newer product they could still buy
but people still value them, people still have the flair of design, I mean people
keep them.” (DesT-m)

Although the interviewees would not necessarily be familiar with sustainable design
theory and Design for Sustainable Behaviour (Lilley, 2009) the importance of the user
and their relationship with products would be considered irrefutable “it’s users plus
system.” (Desl-m)

4.3.4.4 Awareness of EcoDesign Approaches/Resources

The participants were asked about their current understanding of EcoDesign and
whether they had implemented EcoDesign principles in any of their work. Most of the
responses were quite general, with some knowledge of the importance of product life
cycles, cradle-to-grave and Cradle to Cradle.

“It’s saying what’s the right approach to this product? Should we make it last
a long time? Should we make it very disposable? Should we make it totally
bio? Maybe there are multiple approaches, and then you do concepts in
those areas.” (DesT-m)
“I reckon it is when you design considering all the impact that you’re creating, so whether it’s positive or negative, trying to always to get the most positive impact as possible keeping the negative impact to the lowest. I guess that would be like the simplest way to see it.” (DesS-m)

“I’m not being very eloquent here but, EcoDesign would encompass everything from concept through to manufacture to usage, you know, the whole product life cycle. Yeah, is it generating any positive or negative impact and what is the extent of that impact on the environment? When you’re manufacturing the thing, it has to be considered all throughout the development life cycle of the product, right from the initial idea wherever that idea has come from really.” (DesL-m)

“I mean if you’re looking at it as sort of from cradle-to-grave, you know, in terms of how much energy was used in the – we’re not doing analyses of how much energy – inherent energy has gone into creating that product right from the start point to it failing.” (DesO-m)

“Our products aren’t necessarily eco in themselves for just the – without considering the use, but when you put a chicken in it, and somebody’s using it for years and years, and then they’re becoming self-sufficient, you need to look at the whole life cycle analysis, but you couldn’t look at a particular component of that product and say that’s an eco-component or an eco-product. We haven’t really assessed our designs in any kind of quantitative terms.” (DesK-m)

The SDCs above were not necessarily implementing these ideas in their own work. However, there are signs that it is something the interviewees were considering.

“Life cycle analysis is something that we’ve been looking into, and it’s clearly more important at design level than any other level within the manufacturing
process. It’s much more important that you do that right at the beginning and analyse it right then, rather than later on.” (DesX-m)

“It’s saying what’s the right approach to this product? Should we make it last a long time? Should we make it very disposable? Should we make it totally bio? Maybe there are multiple approaches, and then you do concepts in those areas.” (DesT-m)

“I tried out Sustainable Minds (Sustainable Minds, 2008) but I didn’t particularly like it, mostly because it bundled everything into one score. You’d still need to be thinking about energy at the right stage of the process, and traditionally you did it with LCAs and stuff that were fantastically detailed but done at the wrong stage in the process.” (DesT-m)

“We did engage the services of a consultant to basically put together a carbon footprint for the product. But that was a free consultancy through ENWORKS (ENWORKS, 2010) so European funded.” (DesL-m)

4.3.4.5 Material Choice

Whilst the previous section shows that there is quite a wide understanding of the different EcoDesign approaches and that it can be very complex. Many of the participants were much more comfortable talking about material choice, especially when considering their own work.

“There are materials that we wouldn’t use. We wouldn’t use PVC because of its environmental issues.” (DesO-m)

“Apparently basically every type of colouring that is green, the colour green, has got a nasty copper chemical in it, which basically makes it the worst colour you could actually pick as being green-green. Ironically enough.” (DesP-m)
“So the two of us were, you know, at various points around the project discussing things like reducing the amount of aluminium used or if recycled aluminium to a higher proportionate was feasible.” (DesL-m)

“Most of the things are – don’t include any glass filling, talc filling, so we avoid – that’s our um, we’d always see glass filling or talc filling, mixing any kind of plastics as a last option that we’ve covered every other ground before that because it’s pretty nasty to recycle. I don’t know I haven’t really researched it that much, but I’m just guessing here but you might pick a PVC material or a tarpaulin material that – um, in the material terms it’s a pretty nasty thing, but actually if it’s going to last so much longer and just going to do its job for – forever, then it’s all right.” (DesK-m)

“Or you really go recyclable materials and environmentally friendly materials. We kind of split down the middle as much as we can. So we come from it as logistically and efficiently. But as well as ... well if there is a material, is there one which we could use which is better for the environment?” (DesN-m)

It was also clear that materials had to meet the other requirements of a project, as well as having a reduced environmental impact, in order to be chosen by the designers.

4.3.4.6 Risk of Criticism/Greenwashing

There was a lot of awareness of other designers work, and where environmental claims might be naïve or untrue.

“I went to the toy fair right, and there’s this one stall, and I was like here we go, bloody bamboo right and he’s got these little plates and stuff, and he was like yes, it’s all biodegradable bamboo, you know all biodegradable materials. I said, ‘so can it get wet then right?’ and he said ‘yes, yes, yes it’s covered in a lacquer and it’s dishwasher safe’, but I was thinking hang on, what materials would actually do that and he said, ‘there’s no plastic in it, no there’s no plastic in it whatsoever’ and I was like well ‘what’s the lacquer then?’ And he’s like ‘I don’t know, but there’s no plastics in it at all’ and I was like well all right then
if your lacquer wears off, will it just decompose or what? It’s just sad because you know all these people without any knowledge are programmed to tell the world that this is the future.” (DesP-m)

If you are making those claims, it is debatable what it’s doing for you and the whole greenwash side of things is people become cynical about therefore you could make the claim, and actually people say, ‘Well, I don’t particularly believe you anyway.’” (DesX-m)

Sometimes, even if claims are correct, criticism falls on all previous products for not meeting the same standards. So, it can be easier for clients not to mention the environmental credentials of a product, rather than risking opening up an unwanted debate about all their products. However, this has not necessarily been the case with electric vehicles (EV). Many automobile manufacturers have EVs as part of their portfolio, but this has not brought widespread criticism of their conventional cars.

“Tesco’s is doing a whole load of sustainability things then they know that if they say too much then they’ll get bad criticism in the press because, ‘Look, Tesco are making this claim and yet they’re still doing this.’ And actually it backfires on you and I think that’s another big risk about the whole thing at the moment is that people are scared about making claims because of the greenwash issue.” (DesX-m)

Another issue was the precaution taken when investing in new products, something that relates back to the ‘me too’ briefs in Section 4.3.1. When investing more broadly, or specifically in a new product, “it is better for reputation to fail conventionally than to succeed unconventionally” (Keynes, 1936, p.158). So, when making a choice about which products are brought to market, if the product is conventional and fails, any number of reasons can be given for this lack of success. However, if an unorthodox design is approved, and the result is unsuccessful, the person who made that decision is likely to be blamed for any lack of success. So, following others may help individuals to maintain good reputations (Baddeley, 2010).
“As a designer, you’ve got the vision to say, ‘No, you don’t want to do that. You’ve got to do this.’ But at the same time, we’re not generally in that position, we’re not strong enough to be able to say, ‘You shouldn’t do that, you should do this because it’s a big risk for us.’ If their sales fall off, then they’ll blame us. And it’s a big risk for them because if the sales figures fall off, they’ll say, ‘Well, why the hell did you let that design company go off and do that? You should’ve stuck with what we know.’” (DesX-m)

This aversion to risk is a challenge for EcoDesign, and where perhaps the Economically Viable tends to trump the Environmentally Benign. This is why an SDC has to be very confident in their design proposals and/or have an EcoDesign champion within the client company, see Section 4.3.4.

4.3.5 Sources of Information

SDCs are expected to carry out a wide range of projects, and even the larger organisations cannot be knowledgeable across all the fields that their clients may require. Designers are regularly expected to learn about relevant topics in the course of a design project. The interviewees were found to use a whole range of tools and techniques to search for the information necessary to carry out their work.

“It depends what stage you are in the process because if you’re writing a proposal then books, magazines, internet, online forums are really good at adding grit to your proposals.” (DesF-m)

4.3.5.1 Colleagues or Contacts

The preferred way to find information was to ask colleagues or other contacts that the designer has built up over time. This is a very quick way of gaining knowledge from a trusted source and tends to be much more targeted than the internet. However, the range of information is limited by the size of the network any individual or organisation may have. This group is also likely to be dependent on past projects, making it difficult to extend knowledge into new fields. However, before making contact with other people, it was considered necessary to have done as much research as possible beforehand. This is partly to have a clear idea of the questions that need to be asked,
but also not to waste the time of the questionee on information that could easily be found elsewhere.

“It would almost be disrespectful to them if I called them before I had done my bit. Because if I phoned them up and haven’t got a clue about what I’m talking about, I’m going to sound like a real idiot, and they’re not even going to really want to answer the question. If on the other hand, my questions are really quite specific, they’re going to think, this man knows what he’s talking about, so I’ll give him the five or ten minutes of my time.” (DesG-m)

“When we do our research process, we get as much knowledge as we can whilst just sitting at our desk.” (DesT-m)

Parts of projects were also sometimes outsourced to experts if the work was too complex to be completed within the SDCs. This tended to be either the design of electronics or high quality prototyping.

4.3.5.2 Suppliers or Manufacturers

As was found in the pilot study material suppliers and manufacturers were frequently mentioned as good sources of detailed information about material limitations and manufacturing techniques. In a similar way to asking colleagues or contacts, it was considered important to spend some time understanding the problem and having some idea of what the solution might be before contacting outside sources for information.

“We really encourage people just to read as much as possible about a new process, so you are asking the right questions. Then the easiest way is to have a stab at what you think it’s going to be. Send it to your manufacturer to have a look at, hopefully, somebody you’ve got an existing relationship with and then it’ll be backwards and forwards to find a solution between you.” (DesK-m)
4.3.5.3 Internet, Online Forums and Blogs

Although the favoured methods to search for knowledge are using contacts and suppliers, the internet plays a major role in this process. It is seen as the starting point for other techniques because it is such a quick way to access large amounts of information.

“Well, obviously the internet has made a profound difference to the way one works.” (DesM-m)

“There’s a lot of like SlideShare (2006), TED (1996) and those kind of things now where if someone’s given a presentation at an event, you can find it or – people talking around it or comments on it.” (DesJ-m)

“I mean the predominant way of finding information is through the internet. If we need to find something now, you’re straight on the internet, and you can find an answer.” (DesO-m)

“On a design project, day to day for a kind of practical information would be the internet and phoning up suppliers. So most of the time I just go straight to Google (1998) and find someone new.” (DesI-m)

“The internet is a huge vehicle for learning for us.” (DesQ-m)

“If a brief is to kind of search out for new materials, that's kind of just done like by the internet.” (DesY-m)

“The brochures and technical data online is, as a resource, it’s unrivalled really.” (DesL-m)

Part of the appeal is that the internet enables designers to widen their network of contact through online communities and forums.
“The great thing about open source communities or forums, they’re dynamic and evolving, organic.” (DesK-m)

However it tends to be much less targeted than other techniques, and the quality of information collected is very dependent upon the search terms, and the ability of the user to filter out appropriate content.

4.3.5.4 Books, Magazines and Trade Publications

Very few of the designers use books anymore, and when they are used, it tends to be for very specific reasons. Most of the SDCs had a set of reference books which included information about manufacturing processes, materials information and mechanical equations. Trade catalogues might also be used because they can be easier to navigate than their online equivalent, but always alongside their websites to ensure details are up-to-date.

“I don’t use books at all; I don’t think. We do have a bookcase downstairs with engineering technical stuff, and we’ve got some sizing information, things like that for human factors.” (Desl-m)

“Sometimes I’ll have a design magazine, and I’ll just spend 35/40 minutes reading that and enjoying it. Actually, I don’t always read that at work, I’ll take it home to read in the evening.” (DesG-m)

Magazines were mentioned as a source of inspiration, but this was often more to do with designers having a general interest in their field, rather than searching for specific information. In general, this kind of browsing has moved from paper-based mediums to their online equivalent, partly to save money, but also because there has been a move away from printed media throughout society as a whole.

4.3.5.5 Tools/Software

Compared to the extensive use SDCs make of software in general, and in particular Computer Aided Design (CAD) packages, there was very little use of software by the
designers to find information. However, this was not necessarily because they did not like these types of solution. They were quite keen to have the ease of use computer programs provide, combined with much more targeted content than is available on the internet. The main barrier to more extensive use of software, in this context, was whether it could be billed to the client. Alternatively, SDCs can take advantage of free trials offered by software companies.

“If you can get a free demo or something, a 30-day demo is often enough to do a project, and then you don’t have to ever use it again.” (DesI-m)

“I’ve tried SimaPro (PRé Consultants, 2015) but it’s a little bit complicated really. I was very interested in openLCA (GreenDelta, 2006) I thought that might have been a good thing, but the database is still quite a lot of money.” (DesH-m)

“I tried out Sustainable Minds (2008), but it’s kind of crap in terms of workflow because if you’re already past the kind of sketch stage. I also find like the Eco-indicator 99 (PRé Consultants, 2000) score frustrating.” (DesT-m)

The main issue with Life Cycle Assessment tools, even in their more simplified forms was that it was seen as a retrospective tool that could still be very difficult to use. In situations where the same type of product is being created multiple times, LCA becomes more practical. This may fit with the ‘mature’ or ‘regulated’ briefs, see page 100, though the LCA would probably be completed by the client anyway.

“Oh yeah, the Energy Trumps (The Agency of Design, 2011) are probably the most useful thing; and they would have been quite a useful source of information I assume, for some back of the envelope calculations on what you were doing, but that’s all.” (DesW-m)

The Energy Trumps (The Agency of Design, 2011) provide key environmental properties such as Embodied Energy, Embodied Carbon, Embodied Water, Recycled Content, Extraction Intensity and Years of Reserves for 45 commonly used design
materials. They are easy to use and are visually engaging, but do not provide any more information than that which could be found online, and are significantly less comprehensive than a tool such as CES Eco Selector (Granta Design, 2008). However, an Energy Trumps deck only costs £12.50.

4.3.6 Information Matters

This section records the wider aspects of information and its communication, as well as issues such as trust and reliability. The interviewees saw learning as part of their job. Given the diversity of their work, there was an expectation that each new project would require new knowledge. This could be about a specific user group, new technology or manufacturing process. Part of the skill of a designer was considered to be the ability to very quickly learn, understand and apply knowledge as part of the design process.

“My point of view on learning is the day you stop learning; you might as well die. When I was at school, I reckoned I learnt so much off the TV, because it was four decent channels you know, so I still remember everything now.” (DesP-m)

“I always sit down every morning when I’m having my sort of Weetabix or whatever. I have a list of links pretty much categorized that I will go through every day just to see if they are doing anything new. So I think there is constantly a little bit of a buzz.” (DesV-m)

The designers interviewed were passionate about design, and their interests went beyond their work lives. Interviewees would look at and read about design and design related issues on evenings and weekends.

4.3.6.1 Trust and Reliability

Designers have a variety of ways to deal with this inevitable dilution of information and the associated accuracy issues. This either involves the use of trusted sources, based either past on experience or the reputation of the creator of the website.
“If the information is on DuPont’s website then there’s a good chance that it’s good and well thought out. If it’s a comment on a forum from a random Joe, then you might take it with a pinch of salt.” (DesK-m)

“I find difficult just to surf the net in search for things. I mean obviously it’s easy in a way, and you can find lots of information, but a really good filter is through magazines and books.” (DesS-m)

“Okay, so it’s got to be a balance between quick, easy to use, but at the same time, you want to be sure the numbers it’s giving you. You want to be able to trace where the numbers are coming from. If you are making statements or judgements based on them, you need to be able to back that up.” (DesT-m)

“This morning I was looking up some information for a chemical that we use and checking to see how it’s regulated. I looked on the EU cosmetics directive website, which I would hope is really reliable, and found a certain amount of information, but I then cross-referenced it through 10 different websites and got really consistent results. So I said ‘Okay, I can feel pretty confident that when I go to our chemist, he’s going to agree with this analysis of it.’ But I don’t think it has to be 10 out of 10. I think 8 out of 10 is still pretty reliable.” (DesQ-m)

The other alternative is to try and triangulate the information. If a number of independent sources are presenting the same information, then there is a good chance that it is accurate. However, all the designers explained that if the information is critical, then they will always check it against a recognised published source, an expert in the appropriate field or someone they trust.

4.3.6.2 Communication and Visual Engagement

It was made very clear that the way information is communicated is extremely important for product designers. Failing in this aspect would undermine any new resource, however well designed the other features might be.
“Designers want to take the easiest and most efficient route possible, and they’re not into hanging around and exploration. They’re prejudiced. If it doesn’t look good, they won’t engage. It’s got to be brilliantly visually accessible, completely intuitive, un-patronizing and if you do an audit on any of the existing tools out there, they’re a complete turnoff, and they’re kind of inaccessible if you think about a designer’s mind.” (DesF-m)

“So to make it usable, I think it’s the case of making it easy for people to upload the information, so it’s not a dedicated team of people finding information and putting it up. It’s a collective thing. Everyone’s doing it. If you can make it shorter, the information, rather than reading pages and pages, it’s so much easier.” (DesN-m)

Visual engagement was not only about communication but also inspiration. If done correctly designers would want to engage with the EcoDesign resource; it would ‘seduce’ them into use.

“You think about first engaging people visually in what’s gonna spark their interest in something. So you look at it and think, ‘Oh, that looks nice’. And that’s what encourages you to probe further.” (DesF-m)

“I’m sure there are opportunities in terms of that layering of how somebody can engage with the information and yeah, that mixture of seducing them sometimes and giving them more depth in other ways.” (DesG-m)

Efficient communication was also discussed. Providing headlines that could then be pursued further were considered preferable to any large blocks of text.

“You want snippets of information to find the stuff relevant. I suppose we always do that, don’t we? We look at the title, mostly for example. Just read that and then find the one relevant to read further.” (DesN-m)

“What I don’t want is a bible of detail.” (DesG-m)
4.3.6.3 Sharing Information

Many of the SDCs and in particular those with more than a few employees recognised that there could be a problem sharing information within their organisations. They realised that this could lead to time being wasted repeating research, but had not necessarily found a satisfactory way of solving this. Most of the companies had shared hard drives to centrally store useful information, though this still requires employees to know what is there so they can look for it.

“I think we definitely, as a company, we could improve in terms of having more of a system a clearer way of both holding information and sharing it. I still tend to send a lot of emails to everybody saying, look at this, or look at this. That kind of thing happens a lot here.” (DesJ-m)

There had been some experimentation in using social bookmarking websites, which allow users to label web pages with topic tabs so that they can be searched more easily. This information can also be shared between a network of people so that they can all have access to the information.

“We do things like Delicious (2005) and Diigo (2006) now as well which is the one that kind of more – maybe is more using now. And that’s again more social I suppose – but it’s also good for sharing information and on projects, and I’ve actually been using it for reporting back to clients as well. Where I – we were ta-, you can tag things basically, so it’s like online bookmarks.” (DesJ-m)

However, despite using this technology, the lack of an official system means that employees often revert to ad hoc ways of sharing their knowledge.

4.3.7 Legislation and Solutions

The Clustering Matrix process created a Legislation and Solutions cluster. This is because some of the solutions referred to current legislation in both positive and negative ways. Equally, integration of existing environmental legislation, directives and standards into an EcoDesign resource was discussed by several interviewees.
4.3.7.1 Environmental Legislation, Directives and Standards

None of the designers interviewed had much more than a superficial awareness of environmental legislation, directives or standards. This was mainly because they did not need this knowledge, either because it falls under the remit of the client, or whomever they outsource specific aspects of a project to. Many of the environmental restrictions are directed towards or affect electrical appliances, but this sort of specialist design was not being carried out by the SDCs interviewed.

“I don’t really know what any of them mean, like the WEEE directive. I couldn’t say what that stood for. We don’t adhere to any directives for sure because we’re barely aware of any.” (DesK-m)

“I’m not aware of directly any regulation that affects choice of materials in terms of, you know, because if it’s a lower carbon footprint to manufacture or something like that.” (DesM-m)

“So no I didn’t know of WEEE if I’m honest. Obviously, if we were to do an electric project, then we’d have to look at it then.” (DesN-m)

Don’t know; I’m not sure what you mean by WEEE Directive, EuP. What are those things?” (DesS-m)

“I only a little bit about the WEEE eco laws. A little bit of that. Does it have to break down or be able to be broken down into its constituent parts to be recycled?” (DesV-m)

Perhaps one of the most telling quotes was “We don’t adhere to any directives for sure because we’re barely aware of any” (DesK-m). This attitude was widespread, partly because the interviewees were not taught about this legislation as undergraduates, and have had no reason to use them since; they continue to have limited knowledge of their existence. This was sometimes the case, even when the interviewees were taught
EcoDesign or Sustainable Design as students, because their courses did not focus on specific regulations, like WEEE.

4.3.7.2  Suggested Solutions

The majority of suggestions were for a web-based resource that would be visually interesting and easy to use.

“It’s just like a grid of pictures that takes you to kind of interesting design things, and with a little bit of a description.” (DesU-m)

“Maybe it’s about building a platform of communication, and then on top of that you lay this layer of information on it.” (DesZ-m)

“I don’t want to research materials right to the last point. Designers are jack of all trades designers. If someone is designing a car, they’ll search for ‘cars’ rather than steel or whatever, that’s the way I would come at it.” (DesN-m)

Alongside this the resource would include an element of collaboration and networking, either integrating or using similar elements as existing social networking systems.

“If you can have the equivalent of like the way Wikipedia (2001) works or the way the internet works or just a good website where you can dip into rich information, y’know linked information then maybe that’s a way of doing it.” (DesG-m)

“A kind of forum will be a good idea, where it’s more like an open question, an extension of what we do already with people we know, but on a bigger scale. That would be brilliant.” (DesS-m)

“Maybe it’s about designing a collaborative online software like Google Docs (2006). It’s less about the actual content and more about the medium.” (DesZ-m)
“You could have a Twitter section, because most designers I suppose, and most companies will have a Twitter account, and they could just go boom new material, then that has a link to the thing.” (DesN-m)

Other approaches included plug-ins for existing software, like SolidWorks Sustainability Xpress (Dassault Systèmes, 2017). This was suggested as it would link seamlessly with existing workflows. However, this sort of solution would only be of use once a project reaches the CAD phase, which is not necessarily the optimum time to be considering sustainability.

“Maybe if there was a bit more, like those plugins to software that we use or CAD packages.” (DesZ-m)

A more systemic approach would be to create a recognised and accredited EcoDesign Methodology that designers could follow. This is similar to the existing Cradle to Cradle Certified™ (MBDC, 2005) products program.

“So a methodology for dealing with a client for example would actually be a politically useful tool, because if you say, well look, we’re going to go through this standard and we have to get the particular checklist of stakeholders together to go through a particular set of points – as a political exercise that’s actually probably going to have more impact than a designer sitting on their own considering X, Y and Z.” (DesH-m)

4.3.7.3 Warnings

The interviewees gave some specific advice on what not to do. These can be summed up as: Include your users in the design process; Minimise complexity and Make sure it stays up-to-date.

“Do not do what they did at Cambridge (i~design, 2007) and inveigle your way into the whole process and do question and answers. They didn’t have
any way of demonstrating how useful it was to everyone involved. They were like, ‘please pay attention to this’. You need some kind of way in.” (DesF-m)

“What I don’t want is a bible of detail.” (DesG-m)

“Bad websites that you kind of go on and they kind of look like they haven’t been updated for about fifteen years; you think well if the website hasn’t been updated how reliable is this; especially if you’re looking for kind of up-to-date stuff.” (DesU-m)

4.4 Conclusions

The designers in this study experienced briefs of varying length, from one word to many pages. However, very few of these briefs had an environmental agenda. Generally, the products produced only included eco-features as part of the general cost and efficiency improvements or eco-stealth on the part of the designer.

It was clear that in many situations designers working in SDCs can have a greater level of influence over projects and design briefs than would be expected in larger companies. The briefing process was very often a collaborative process, where SDCs work to find agreement with the client rather than being directed by traditional top-down decisions.

There was an awareness that EcoDesign can be very complex, particularly if you intend to make a quantifiable claim, such as the embodied energy of a product. This complexity, or lack of knowledge, stood as a barrier for SDCs to including EcoDesign in design briefs. There were other reasons why both designers and their clients might be reluctant to label products as EcoDesign, especially as there is a perceived risk in bringing ‘unconventional’ products to market. The interviewees had not found that any existing EcoDesign tools had significantly helped them in overcoming this problem.

The designers were very unlikely to use books, or similar printed documents to learn about developments in materials and manufacturing. Their main sources of information were colleagues and others in their business networks, such as suppliers. There was also an extensive reliance on the internet, but with a recognition that the quality of information could not always be depended upon. There was an acceptance that with such a broad range of data on the internet it could be like ‘panning for gold’ (DesD-p),
but techniques had been learnt to help deal with this. There are several aspects of the internet that the designers found useful. It is generally much more up-to-date than printed information, there is an enormous amount of available information, and it is easy to use. If a resource could combine these qualities with more targeted content from recognised and trusted sources, it could prove incredibly useful. Some interest was shown in online social bookmarking and that it would be useful if there were an equivalent system that would allow designers to collaborate in their search for more environmentally sensitive design solutions.

Although SDCs can have some control over their briefs and are in a position to influence their clients, they will not have the confidence to include ecological principles in their design process until their knowledge of EcoDesign has improved. An intuitive and engaging interface that inspires its use and integrates well with the design process would help facilitate this. Information distilled from the main study was put together to help guide the creation of an EcoDesign resource which tackles many of the perceived barriers discussed in this chapter. The guide includes a comprehensive list of all the websites used by the interviewees, and can be seen in Appendix P. This guide was used in the creation and development of the resource, as described in the following chapter.
5. RESOURCE DEVELOPMENT AND TESTING

This chapter describes how the findings from both the literature review and the empirical studies were used to design and develop the prototype EcoDesign resource d.eco. The resource was conceived to remove some of the barriers that SDC designers face when trying to develop and execute EcoDesign briefs.

5.1 Introduction

This chapter describes the design of the prototype EcoDesign resource ‘d.eco’ that was developed using the criteria identified in the Chapter 2 literature review and Chapter 4 main study.

The development and testing of d.eco was done using the website wireframing and rapid prototyping software Axure RP Pro (2015). Although Axure is an industry standard for creating website prototypes, the researcher did not have the necessary skills to use this particular program. So, support was provided by Loughborough Design School staff who taught Axure to undergraduates as part of the User Experience Design module.

An initial Axure prototype was made available to three pilot users before it was rolled out to all the participants. A suffix of ‘vp’ was added to those involved in the validation pilot. Further details of all participants can be found in Appendix I. The initial prototype was presented as a work-in-progress, in order to encourage the participating designers to critique d.eco and offer up suggestions for improvement.

The name d.eco evolved from the premise of adding eco as a prefix or suffix to existing words, so at one point would have been ‘design+eco’ or ‘d+eco’. However, the final version is cleaner and was probably influenced by Stanford d.school, art deco and Elle Deco (Ogundehin, 2017) magazine. Also d.eco in a sans serif font works well graphically as part of the layout, adding to the feel of a designer-friendly website.

5.2 Design of EcoDesign Resource

It was made very clear in Chapter 4 that a web-based resource would be most appropriate for the SDC designers. This was reported as their main source of learning, and it seemed appropriate to interact with them in a way that they already use and are comfortable with, rather than trying to change their behaviour significantly.
5.2.1 Resource Requirements

As discussed in Section 2.8 there are three main stages to increasing the prevalence of EcoDesign in SDCs. These are motivation to engage in EcoDesign, the capability to carryout EcoDesign projects, and the ability to influence clients (and customers) into adopting these EcoDesign products. A number of requirements were highlighted in the literature review and main study, they formed part of the guiding principles for the design of d.eco. Many of the additional supporting quotes from the main study can be seen in Appendix P.

A) Rather than just offering an evaluation of concepts at the end, the resource needs to provide support at different stages of the PDP. In particular being given the information and confidence to include EcoDesign when collaborating with clients in brief creation stage.

B) It should build awareness of good existing examples of EcoDesign, not only to help and inspire designers interested in EcoDesign, but also persuade those currently opposed to it. Existing product provide good evidence of the feasibility of a design, as well as providing information about the materials and manufacturing processes used.

C) Through seeing and evaluating examples on d.eco, as well as having access to the opinions of the whole user base, d.eco provides the opportunity to develop confidence and highlight examples of greenwashing. Trust and reliability were key issues highlighted in the literature and main study.

D) d.eco expands the current professional and personal networks that designers can access by providing an online social networking service (SNS) that enables a worldwide connection to people who share similar interests. This expands on the existing practice of connecting with people within the industry when looking for trustworthy sources of information.

E) Designers are generally passionate about design, and it is part their lives, extending beyond the workplace. Designers think about and engage with design in their own time, as discussed in Section 4.3.5. Tapping into these existing activities aids the normalisation of EcoDesign.

F) Content is provided by users, which keeps content up-to-date while removing the need for large-scale curation. d.eco includes elements like that of the social news aggregation website Digg (Betaworks, 2004), web content rating and
discussion site Reddit (2005) and social bookmarking site Diigo (2006). This provides a way of aggregating the opinion of all users rather than needing to pay expert curators. Limitations of this approach will be examined in Chapter 7.

G) The layout and interface of d.eco echoes that of Core77 (1995), Dezeen (2006), Digg, and Notcot (2005). These were websites particularly popular with the SDC interviewees; there were a number of others, which can be seen in Appendix P. There are similarities between the layouts of these four websites and given their popularity, they provide a familiar graphical interface for d.eco users.

Motivation is perhaps the most difficult element to achieve, and is not really addressed by any existing tools or resources. Encouraging designers to engage with EcoDesign in an environment that already feels familiar helps with the normalisation process. If they can take that initial step, then cognitive dissonance and confirmation bias can do the rest. This is why there was a need for the layout and interface of d.eco to reflect the resources designers already use.

The capability to carry out EcoDesign requires knowledge and access to information. Given that SDC designers are frequently required acquire new knowledge as part of their design process, not too much focus has been put on this because there are existing designer-friendly EcoDesign methods and tools that fulfil this element already. Whether this reliance on the research skills of designers was justified, or if there should be some existing tool recommendations and explanations provided as part of the d.eco resource is discussed further in Chapter 7.

The ability to influence clients is very important, especially, as the main study revealed, the level of input that SDCs can have to their own briefs. In order to do this designers need to be motivated and confident in their ability to carry out EcoDesign projects. These things come from the two previously described elements, but can also be enhanced by the availability of good examples of existing EcoDesign products. Providing a trusted source which has products selected and ranked by design professionals can be good evidence to build confidence and persuade clients.

Rather than being a tool that designers would consult only when working on a specific brief or project, d.eco is a resource that should be visited on a regular basis. As described in Section 4.3.5.4 and Section 4.3.6 the interviewees maintained an interest in design and the wider associated issues, when at home as well as work. This type of regular immersion and normalisation should improve the efficacy of d.eco to motivate SDCs to integrate EcoDesign principles into their practice.
5.2.2 Axure Prototyping

Axure RP Pro (2015) was used to prototype the d.eco website resource. Axure enables functional website prototypes to be created without the need for coding. Interactions are facilitated using built-in widgets, data-driven interactions and conditional logic functions. The conditional logic is made up of ‘if-then’ relationships such as “if condition(s) X is met, then action(s) Y will be executed.” Complex actions can be achieved using a combination of fairly basic logic functions.

The first stage of the process was to create a wireframe, which defines the layout of web pages and demonstrates which interface elements will exist on each page. Initially, this wireframe was sketched out by hand and then transferred to Axure once all items had been confirmed. Appendix Q shows examples of an initial sketch and subsequent wireframes. However, while these images demonstrate some of what Axure does, it cannot convey all the underlying logic that can be accessed when using the actual software. Once the wireframe had been created, and associated logic functions added, it was possible to test the performance of the website before adding specific content. After several iterations, the required functionality was met, so the researcher provided images, text and URLs to populate d.eco. It could then be published to the Axure Share server, which meant the pilot users could access it like any other website for initial testing. Axure allows the layout to be optimised for multiple devices based on one core model. This meant that the validation process could be carried out on any device chosen by the participant.

5.2.3 Resource Function/Navigation

In order to best understand how d.eco works the following section will be a walk-through as if using the website. Having entered the appropriate URL, users would see the login dialogue box, as shown in Figure 5.1. Not having created an actual user database, the Username and Password can be completed with any letters and the website will function. A box does need to be clicked to indicate a Community, which corresponds to a specific aspect of EcoDesign that is of interest to the user.
Figure 5.1: d.eco Login Page

Once ‘Log In’ is clicked the user can enter the website. The main screen is displayed as seen in Figure 5.2. The top line is filled in accordance with the login details. In this case, PRODUCT and RMawle have been added alongside the permanent WORLD heading.

Figure 5.2: d.eco Front Page
There are several underlying elements that influence the way in which d.eco displays information. With reference to Figure 5.3, clicking ‘A’ or ‘+New’ allows the user to add a ‘story’ to d.eco, this allows a link to be pasted, which then populates ‘B’ with an image and a title. Clicking on the title will open the associated website in a new browser tab.

Figure 5.3: d.eco Front Page Explanation
Interactions with a story alter its position on the page. The magnitude of this effect is dependent upon which section of ‘C’ is being viewed. Figure 5.4 shows the WORLD view, which means the position of the story is dependent on interactions by all users of d.eco. When in the PRODUCT view, interactions of those logged in using the Product Community control the position of the story. The USER (in this case RMawle) view just reflects the choices made by the individual user. This system enables the user to see the combined opinions of multiple users in a visual way, based on size and position of the stories and their images. Stories that appear in ‘D’, see below, are the highest ranking in that view, which in this case is WORLD, but the position is the same for the other views. This means that the interactions of users have pushed them to the top of the page, in a similar way to web content rating websites like Reddit (2005).

Figure 5.4: d.eco Front Page Ranking
The movement of stories is controlled by the decisions that users make. By clicking on a story like ‘B’ or ‘E’ (see below) the Comments and Info tabs can be accessed. This provides an opportunity for users to indicate whether they believe the story covers any of the six EcoDesign topics shown in ‘G’. Comments can also be left in ‘F’.

Figure 5.5: d.eco Ranking Criteria
As more topics are clicked on ‘G’, the ‘Monochrome marble tableware designed by Bethan Gray’ story moves up the ranking. If this is being done in the USER (in this case RMawle) section, it will move up relatively quickly. However, in the PRODUCT and WORLD views, it will take longer because rankings are dependent upon more users.

Figure 5.6: d.eco Ranking Movement
If many users are making similar decisions, then the same story could be pushed up the ranking across the board. It is more likely that there will be different stories in the top three in WORLD, PRODUCT and USER. However, if a topic were to start trending or even go viral, spreading widely and rapidly, it could affect all three areas of d.eco.

Figure 5.7: d.eco Further Ranking Movement
The six EcoDesign topics shown above in ‘G’ are Packaging, Length of Life, Production Energy, Material Selection, Impact of Use and End of Life. These are not all the areas that could be considered, but cover the main topics SDC interviewees recognised. A more developed version of d.eco could include more topics, or give users more control over which ones are associated with each story. The main aim of the d.eco prototype was to test the functionality and interface, as well as the underlying ideas, rather than create a perfect finished product.

In addition to the ranking position, the holding image for the stories increases the more frequently it is clicked, see below. This is based on popularity rather than quality.

Figure 5.8: d.eco Popularity Size Change
5.2.4  Content of d.eco

The content of the d.eco was chosen to represent the types of websites that the participants would already be reading, such as Dezeen, Core77 and TED. However, stories were picked from these publications and others like TreeHugger (2012) that tackled subjects such as renewable energy, low-energy living, resource efficiency and sea-level rise (Global Witness, 2014; Griffiths, 2014b; Griffiths, 2014c; Griffiths, 2014a; Griffiths, 2014d; TED, 2014; Lepisto, 2014; Mok, 2014b; Mok, 2014a; Owen, 2014; Quah, 2014; Richard, 2014; Winston, 2014) in a visually interesting way.

5.2.5  d.eco Presentation Style

The presentation style can be seen in the previous figures that included screenshots of d.eco. As discussed in Section 5.2.1, the d.eco prototype mimics websites such as Core77, Dezeen, Digg, and Notcot. All of these websites are essentially built around columns of images, all the same size, fitting within a grid. Generally, they are three column grids with square images, each with some headline text. They all have plain white or light backgrounds and provide sufficient negative space to help clearly delineate each story. This does not perfectly describe all the websites mentioned, but none of them is too far outside this model.

In addition, some simple typographical rules (Lupton, 2014) were followed:

> Font sizes were kept consistent for headings, subheadings and copy text.
> No more than two font types were used per page.
> Rather than multiple fonts, bold or font size was used for emphasis.
> A basic colour palette was used: black, orange and shades of grey.

This version of d.eco was a prototype created to test specific elements of the design. Ultimately this means d.eco is fairly basic, as a number standard features would need to be added before public consumption. This would include things like a search function and sections such as Help, About and Contact.

5.3  Prototype Updates

Following the initial three user pilot, a number of changes were made to d.eco before it was sent out to all the participants. Notes of the changes made at the time can be
seen in Appendix R. One element that was not considered clear was that the Top Stories always remain at the top of the d.eco page. As can be seen in Figure 5.9 a labelled banner was added at ‘H’. Also, it was thought unclear that the stories below the top three were ordered by time. So the latest stories always appear below the Latest Stories banner at ‘I’, it is just the size of the images that varies with popularity.

Figure 5.9: d.eco Top and Latest Stories
Given the simplicity of the initial prototype is was suggested that the process of adding a new story be made much clearer. With reference to Figure 5.10, clicking the cross in ‘A’ or ‘+New’ causes the ‘Add new story’ interface seen in ‘J’ to pop up. Here a title can be entered for the new story, and a link to the associated website pasted in.

![Figure 5.10: d.eco Add New Story Interface](image)

Adding the URL then pulls a number of images into d.eco that can then be selected from, to best represent the story. The images can be scrolled left and right by clicking on the arrows shown in
Figure 5.11. The final selection is confirmed by clicking the Submit button, and the image is placed in position ‘K’ as shown below.
A few, more subtle, changes were made to the Info and Comments interface as shown in Figure 5.12. The specific instruction “Select Relevant Topics Below” was added to make it clearer that the user should make decisions about the six EcoDesign topics shown in ‘L’. The close icon was made larger in ‘M’ and ‘N’ was added as a shortcut to return the user to the top of the page. These triangular icons appear regularly on the left side of the page to take the user straight back to the ‘Top Stories’ section.

5.4 Summary

This chapter describes the layout, interface and content of d.eco, the prototype resource which was developed using the criteria that were established in Chapter 4.
Although it is not the first attempt to apply design principles to the development of an EcoDesign resource/tool, it does offer a unique approach to improving the awareness and understanding that designers in SDCs have for EcoDesign. One of the main differences derived from looking specifically at how SDCs learn about developments in design and echo this existing model, rather than creating an entirely new interface, tool or resource.

The design of d.eco followed the findings from the main study, which was based on the contribution of 26 participants from 22 different small design consultancies. So, at this stage, it should neither be seen as a definitive EcoDesign resource for all product designers, nor as a finished product, but as a medium through which the generated theory could be tested, and ultimately some of the research objectives met. These findings are discussed and applied in the following chapters. Chapter 6 outlines the findings from testing the prototype resource, which are then compared to the conclusions described at the end of Chapter 4, and the requirements derived in Section 5.2.1.
6. RESOURCE EVALUATION

This chapter presents the findings of the d.eco resource evaluation study, which was conducted using online questionnaires. This was carried out to gain feedback from SDC designers and confirm whether the guiding principles used to create it were appropriate and if it embodied the findings of the Main Study.

6.1 Introduction

Having created the d.eco resource as described in Chapter 5, it was made available to 16 participants to evaluate using an online questionnaire, which can be seen in Appendix J. As discussed in Section 3.6.2 online questionnaires are comparatively fast and efficient to administer and analyse especially when respondents come from a wide geographic area. Having contacted them by email, nine of the original main study interviewees agreed to take part in the evaluation process. Also, seven new participants were recruited, three of whom were used to pilot d.eco and the survey process before it was rolled out to all the participants. The demographic characteristics of participants were very similar to that of the main study, see Section 4.1. The main difference was that the participants had more experience, but this was mainly due to the time elapsed between the two studies. The original participants kept their original designation, but the suffix was changed to ‘v’ for validation, for example, DesC-v. New contributors were given codes starting with ‘Des’ followed by a letter from AA-AZ representing the order in which they were contacted. A suffix of ‘vp’ has been added to those involved in the validation pilot. Further details of these participants can be found in Appendix I.

Having agreed to take part, participants were sent an email containing links to the d.eco website and the online survey. A set of basic instructions were also attached to the email, and can be seen in Appendix J. The introduction to the survey included participant information, including the right to withdraw, and that all information would be treated as confidential. Participants replied in their own time over a period of two weeks. The Research Methodology, Chapter 3, gives full details of the data collection techniques, analysis and underlying research philosophy.

6.2 Analysis of Collected Data

As described in Section 3.6.2, there can be a close resemblance between the list of questions used for an interview and a questionnaire, especially if the questionnaire
includes open-ended questions. Hence, the data collected from the d.eco evaluation were analysed in a very similar way to those of the Pilot Study and Main Study. One advantage provided by an online survey service like SurveyMonkey (2017) is that the websites includes analysis tools. It is also very straightforward to transfer the online data into Computer Assisted Qualitative Data Analysis Software (CAQDAS) like NVivo (QSR, 2014). When considering coding, this could have been done just by identifying themes in the text. However, the survey data allowed word cloud analysis by SurveyMonkey and NVivo, the results of which can be seen in Appendix S. The prominent response words were mostly tied directly to the phrases in the question, which is unsurprising, as questionnaires are often initially coded by the question topics (Bryman, 2008), with additional codes being determined by the type of response. Furthermore, having exported the appropriate file from SurveyMonkey, NVivo was able to auto code the responses of the participants (Bazeley and Jackson, 2013).

In addition to the open-ended questions, each topic had an associated Likert type attitude scale. Likert scales are designed to gauge the attitude of respondents to a statement, typically giving them five options. An example of the scale used in the d.eco evaluation can be seen in Figure 6.1.

![Likert Scale Example](image.png)

Figure 6.1: Example of Likert Scale from d.eco Questionnaire

There are a number of rules and guidelines associated with using a Likert scale (Bryman, 2008; Preece et al., 2002) which were followed. This was facilitated by SurveyMonkey, because the subscription version features a database of certified questions, including several pre-written Likert scales, created by survey methodologists (SurveyMonkey, 2017).

### 6.3 Results

The questions about d.eco centred around five main aspects of the website, Visual Engagement, Inspiration, Communication, Accountability and Overall Opinion. For each of these areas, the interviewees made a Likert scale assessment and provided
their response to an associated open-ended question. Given the size of the sample, the Likert scale responses were not analysed quantitatively but rather represented in a doughnut chart like that shown in Figure 6.2. These charts show the relative proportion of the recorded responses. The following sections discuss the responses to the five aspects of d.eco. However, there is a separate section where specific suggested changes, such as increasing font size, are included. These are elements that could be easily adjusted in a future iteration of d.eco.

6.3.1 Visual Engagement

Overall the response was that d.eco is visually engaging, as can be seen in Figure 6.2. This was reflected in the comments, many of which were similar to those below.

“In keeping with other Design Blogs. Simple clear and stylish.” (DesAD-v)

“I like the clean layout, but the choice of image used for each link/article will be key in attracting attention.” (DesAE-v)

However, there were some caveats. DesG-v considered d.eco to be visually engaging, but lacking design magic.

“It is engaging. It’s clean and simple and image-rich, but it doesn’t have any particular design ‘magic’.” (DesG-v)

Design magic is hard to define and even harder to create. However, this is something that could be addressed by involving a web/graphic designer in future iterations of d.eco.
In addition to this, there were a few participants who approached the engagement question quite differently. Some participants considered the images unimportant, or at least secondary to content.

“I’m not that bothered about the images. For my purposes, if anything they get in the way of browsing the stories.” (DesL-v)

“If the headlines were very interesting/relevant to my interests then perhaps the visual engagement becomes less important.” (DesAG-v)

“Yes it’s engaging, it’s clean and easy to navigate, consistent theme throughout. Engagement would influence my enjoyment of using the website, but if I found it useful, I would use it regardless.” (DesAC-vp)

It is encouraging that participants felt that if the content were sufficiently useful, the look of d.eco becomes far less important. However, it is not clear that product designers would visit a poorly created website for long enough to find the useful links. Another response was that it is the images chosen for the stories that determine the level of engagement.
“The site is predominately a list of stories, so the level of engagement is mostly driven by the story image.” (DesK-v)

This is an issue, but one that was considered in the creation of d.eco. Whoever adds the story chooses the image based on what is available from the source material. The image may encourage people to click on a story that has less merit than others, but it is the d.eco ranking criteria, see Figure 5.5, that has the most control over the position of stories. This is not directly related to the number of clicks but on the feedback of users who have already read the story. It is likely that certain users will overlook important and relevant stories because they do not engage with the associated image.

6.3.2 Inspiration

Most of the responses were that d.eco could be useful or very useful in highlighting inspirational EcoDesign stories, as can be seen in Figure 6.3. However, the comments were more circumspect than those in the previous section. The main reason for this seemed to be that participants believed that it was the quality of the stories that would ultimately determine the level of inspiration. Given that the d.eco prototype only provided a limited number of stories, the respondents were speculating that a fully working d.eco would be inspirational with the right content.

![Figure 6.3: How Useful d.eco Could be in Highlighting Inspirational EcoDesign Stories](image.jpg)
“By showing a large number of case studies, you automatically see a range of EcoDesign strategies and are asked to engage with lots of issues around Sustainable Design. After reading some of these, you may well naturally think about your own work in terms of these strategies and issues.” (DesAF-v)

“If the quality of the story telling was high, and the outcome of each story had impact, I think this would inspire me.” (DesAG-v)

“If it is easy to browse and presents things clearly, you are more likely to come across something that is relevant to your work, or might spark an idea.” (DesAE-v)

The point about content is pushed further by DesG-v, who identifies the need for an initial critical mass of content, which people find interesting and inspiring before they will be encouraged to add their own. This is something that was touched upon in Section 5.2.1, that whilst having a very light touch curation of d.eco would be preferable, there may well need to be a large time investment in adding stories before d.eco is launched.

“I can see that it would be useful for interested parties as it aggregates environmentally-focused images and stories from a range of other websites and its users are able to decide what is and isn’t interesting in a simple way. I suspect that in order to get going it will need a lot of pushing before the crowd input can become more self-sustaining.” (DesG-v)

The road to self-sustaining content need not necessarily be overly arduous because existing social networks could be used to help recruit people to populate d.eco. Even on a small scale, this would significantly speed up population when compared to a lone curator.

In some sense, the participants have identified two aspects of d.eco without being specifically told about them. In the previous section, visual engagement is critical to enticing users into actually reading the available stories. In this section, the quality of
stories is important in order to have a lasting impact on the reader. Both of these are important aspects of d.eco, which cannot successfully exist without each other.

6.3.3 Communication

The response to this aspect of d.eco was much less clear-cut, see Figure 6.4. Although half of the respondents felt d.eco was effective at communicating EcoDesign information, the others were either neutral or did not find d.eco effective at all.

Figure 6.4: How Effective d.eco is at Communicating EcoDesign Information

The responses fall into two main groups, trust and education. Currently d.eco helps users learn through examples, which follows the findings in Chapter 4. However, some of the respondents wanted expert input either when rating a specific story, or in the form of an editorial. Having a specialist contribute to every story would be problematic, because of the time and money issues, but having regular input from editor/educator could be a viable addition to d.eco.

“I didn’t see any additional ‘editorial’ insight on EcoDesign. The content needs either careful curation (by an individual/group) or a critical mass of active users for the upvoting thing to work.” (Desl-v)
“If the stories were rated by experts as to how impactful the story is then this would be a great improvement.” (DesAG-v)

The issue of trust has been a theme throughout this research project; most respondents thought this would come with time. Knowing how to interpret reviews is something that is increasingly becoming part of everyday life, whether buying goods or booking a holiday, ratings and comments are an intrinsic part of this process.

“It's certainly a good starting point for curating and promoting suitable articles, but I guess it would take a bit of time to mature and for the trust to be built.” (DesAE-v)

Many of the participants were happy to learn through examples. d.eco is not necessarily the end-point, but a place that facilitates existing learning strategies.

“I like the format; I haven’t really engaged in a website which allows the users to do this before, I think it would be interesting to see what is trending within EcoDesign.” (DesAE-v)

“It gives you broad categories for you to investigate yourself further. It doesn’t provide any specific information on principles, just guides you towards examples.” (DesH-v)

6.3.4 Accountability

Accountability was touched upon by some participants in the previous section. However, their responses are more fully developed here. Again, Figure 6.5 shows a mixed response. Half of the participants thought the information in d.eco was reliable, the rest being neutral or not thinking it was reliable at all.
There was uncertainty on whether the ‘wisdom of the crowd’ would be enough to guarantee reliability, especially if the opinion of non-professionals is included.

“I’d have to wait and see how it develops. It’s hard to predict whether the ‘wisdom of the crowd’ will ultimately be more successful than the editorial control of experts.” (DesG-v)

“It depends who is using it I guess. Other professionals would give me a level of confidence due to their levels of experience and knowledge. Not so sure if it was open to the general public.” (DesH-v)

However, some of them somewhat dismissed this worry, arguing that it would be unlikely that the general public would be interested in contributing, particularly since d.eco is a subscription-based service. Although there would still need to be some brand recognition before d.eco could be really trusted.

“I can’t imagine individuals bothering to subscribe who are interested in EcoDesign and who would not want to help strengthen the quality of the website, saying this, however, relevance is subjective.” (DesAC-vp)
“Assuming it a genuine collective opinion, then this would definitely give a level of trust. You’d really have to build the “brand” of the site for it to be trusted.” (DesI-v)

“I don’t think I would automatically trust articles here because I’ve not heard of d.eco before. If it links to something like TreeHugger, then I might trust that more (although I don’t completely trust TreeHugger).” (DesAF-v)

A slightly different issue is manipulation of the story ranking either consciously or unconsciously. Using d.eco to push a specific agenda, or boost visibility for political or financial reasons would be a problem if it were completely unregulated. Having some form of curator and digital analysis of activity should prevent this sort of problem. Though, ultimately no system is totally secure against unauthorised access if a hacker were to devote time to manipulating d.eco.

“It's very dependent on the audience and whether or not the website is susceptible to hijacking by individuals or groups.” (DesG-v)

“There is the risk of very important articles being pushed out of sight by those with less substance but seen as more fashionable.” (DesI-v)

This issue need not necessarily be so sinister, as users might be partial unintentionally, current trends could sway a user to rank one story higher than another. It is challenging to remove all bias when asking opinions, particularly since the viewpoint of the same person can vary with the amount of sleep and levels of hunger (Kahneman, 2012) as well as time.

6.3.5 Overall Opinion

Participants were asked how useful they thought the principles demonstrated in d.eco could be in promoting EcoDesign. As Figure 6.6 shows the response to this was mostly
positive, with some responses being neutral. Overall the message was that d.eco has the potential to promote EcoDesign.

![Figure 6.6: How Useful Could d.eco be in Promoting EcoDesign](image)

The written responses were more nuanced but still very positive. Any caution was centred on the fact that d.eco is a prototype rather than a finished resource.

“I definitely think it could be useful as it’s simple, pure and (critically for designers) image rich so that the process of finding relevant content can be quick and pleasurable. Further to that, if a user wants to delve deeper, they can follow links.” (DesG-v)

“Although I wouldn’t use it as a tool per se, I could easily see it becoming part of my regular morning routine, like checking the weather or news headlines.” (DesH-v)

“I think it looks like a great resource, but it probably needs to be more fleshed out to get a real idea of its usefulness, and to make it stand out from any design/sustainability blog.” (DesI-v)
There were also suggestions on how d.eco might be enhanced by integrating with existing social sharing/networking. Also that d.eco could be used by clients as well as SDCs as a way of viewing existing work and building commercial partnerships.

“I think it would be interesting and could be a feed into other news readers/apps. It could have Instagram (2004), Twitter (2006) accounts that announce new content. I would sign up.” (DesAF-v)

“What’s the model for expansion? How about linking this to collaboration opportunities, perhaps via a Knowledge Transfer Network (KTN, 2005).” (DesL-v)

“Having a targeted EcoDesign resource to submit to, would help designers connect with Eco-savvy customers.” (DesAD-v)

In addition to these more speculative suggestions of how d.eco might reach a wider audience, there were some more straightforward changes proposed.

6.3.6 Suggested Changes

There were a number of suggested changes for d.eco, in addition to those addressed in the initial three user pilot, see Section 5.3. Some of these are quite simple fixes; the following two suggestions could be made very quickly.

“Perhaps slightly increase the 'World', 'Product' and 'Top stories in world' text?” (DesI-v)

“It would be better if you could click on the image as well as a title to go to the story.” (DesK-v)

However, the following was an unexpected limitation of the Axure prototyping software and would have worked in the way DesH-v suggested if it had been possible.
“I like how things pop up or change colour when you hover over them (although I wish the boxes would go away again when I take the mouse away, or have a ‘Done’ button rather, than having to click the ‘X’.” (DesH-v)

There was one respondent who felt having to log-in to d.eco would discourage him from using it. Though there is also the suggestion that it could integrate with existing social media websites. There are already many websites that allow users to sign in with their existing Facebook (2004) or Google account(s).

“Having a separate login system (and yet another login to remember) would definitely put me off if I had just stumbled across it. Combining with other social media sites (e.g. using Facebook comments) might help make it more authentic?” (DesI-v)

Having to register for d.eco has advantages, as DesAF-v points out, there could be an issue of unwanted content, and having a login gateway helps reduce this issue.

“At the moment it seems like anyone can post anything so there might be some dubious content and / or even spam?” (DesAF-v)

A number of the respondents commented on the use of only six Topic buttons, see Figure 5.12. The main issue was that six topics are quite limited, and the current format does not allow for negative labelling of stories. Negative ratings were considered, but like many existing social networking websites, there is not quick click ‘Dislike’ button. The comments section provides an opportunity to give a more nuanced description of any negative reactions to a story.

“The six ‘buttons’ that highlight a story’s interest seem a bit limited. Also, sometimes a story is of interest for inverted reasons [e.g. Bethan Gray’s (Quah, 2014) marble table may be more interesting for its environmental failings, say, in terms of production energy] and this inverted attention can’t be captured simply with the six buttons.” (DesG-v)
“Not certain about the comprehensiveness of the six topics. How about having one about the quality of experience delivered to the user? That factor should be fundamental in deciding how good (including “sustainable”) a product is.” (DesL-v)

The limitation to six buttons is something that could be addressed by having a system similar to many bookmarking and tagging websites, like Diigo or even browsers like Firefox (Mozilla, 2003). Users can create their own tags, but can also select from tags already associated with a particular story. The tags might need to be limited to allow the d.eco ranking system to work effectively, but this number could be significantly larger than six.

The final suggested change was highlighted at the pilot stage but was not implemented in case the additional communities confused the participants.

“Could you allow the user to select multiple categories when signing in? For example, I would be interested in both technology and product.” (DesAB-vp)

“Why only one area of interest can be checked on log-in?” (DesAD-vp)

It would be quite easy to allow additional communities to be added, as the source material for these would already exist on the d.eco servers. Choosing PRODUCT when logging into d.eco merely makes this available to the user. A total of four communities could be viewed with significantly altering the current layout of d.eco. Whilst in the current configuration it would be possible to log-in multiple times to view Architecture, Energy, Packaging, Technology, Business, Interior, Product or Transport. Clearly, it would be preferable to just have these as tabs which can be navigated between easily. None of the participants commented upon the available communities, but these could be modified or expanded if necessary.
6.4 Summary

This chapter describes the response to the d.eco prototype testing. Overall the response was very positive, though some participants were unsure about the issue of content and the level of trust that could be associated with any particular story. Table 6.1 shows the degree to which d.eco meets the resource requirements established in the literature review, main study and discussed in Section 5.2.1. It also reflects responses given earlier in this chapter.

Table 6.1: Degree to Which d.eco Meets Resource Requirements

<table>
<thead>
<tr>
<th>Resource Requirement</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
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<tbody>
<tr>
<td>Accountability - Trust and Reliability of Information</td>
<td></td>
<td></td>
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<tr>
<td>Awareness of EcoDesign Approaches/Resources</td>
<td></td>
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<tr>
<td>Communication and Visual Engagement</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Company Environmental Ethos</td>
<td></td>
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<tr>
<td>Complexity in Practising EcoDesign</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence - Ability of Designer to Influence Clients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost and Time of Practicing EcoDesign</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand from Client or Consumer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples of Successful EcoDesign</td>
<td></td>
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<tr>
<td>Government Policy - Unclear and Changes</td>
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<tr>
<td>Motivation of Designer to Engage with EcoDesign</td>
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<tr>
<td>No Supply of Materials or Components</td>
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<tr>
<td>Pre-existing Opposition to EcoDesign</td>
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<tr>
<td>The Talent or Aptitude of Designer for EcoDesign</td>
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</tr>
</tbody>
</table>

Some of the requirements and their scores are self-explanatory, particularly those at the high and low end of the scale. Explanations are provided below for those criteria.
and results that are less apparent, as well as ones directly addressed more directly in
the survey.
d.eco was considered to be visually engaging, and the respondents reaffirmed the
importance of this aspect of the resource. However, there is definitely an opportunity
to redesign or refine d.eco to have more design ‘magic’, and this could be addressed
by involving a web/graphic designer in future iterations of d.eco.
There is very little that d.eco can do to change Government Policy; the Supply of
Materials or Components; or the Aptitude of Designer for EcoDesign. Although, if
EcoDesign becomes more prevalent, this could lead to changes in legislation and the
availability of materials and components. Aptitude is somewhat fixed, but making the
process of EcoDesign more accessible could mean that those with less ability would
still be able to participate. Company Ethos; Cost and Time; Demand from Client; and
Opposition to EcoDesign also register a low degree because they are not directly
addressed. However if d.eco achieves the normalisation and in turn integration of
EcoDesign principles into company practice this would have an effect on their ethos.
This increases the potential to persuade clients and could increase the demand for
EcoDesign. The cost and time required to carry out EcoDesign is likely to decline with
increased experience. The pre-existing opposition to EcoDesign mainly stemmed from
a belief that is often an excuse for poor design. Providing examples of good design
that incorporates EcoDesign principles is the best way to change this attitude.
Accountability was the area of most concern for participants and whether they could
trust the wisdom of the crowd and their evaluation of stories on d.eco. This issue
nuanced and is discussed at some length in the chapter. A combination of digital
monitoring of user behaviour and regular editorials could go a long way to redress the
misgivings of users.
The most positive response was to how useful d.eco could be in highlighting
inspirational EcoDesign stories. The only caveat to this was that to remain inspirational
the content would need to be extensive and self-sustaining. In order to maintain light-
touch curation of d.eco where possible, there would probably need to be significant
investment in populating d.eco before it is launched.
There were a number of suggested changes to d.eco, many of which could be
implemented relatively easily. However, the overall opinion of d.eco was that it could
be useful or very useful in the promotion EcoDesign within small design consultancies.
7. DISCUSSION

This chapter discusses the findings and results of the previous chapters, responding to the research questions proposed and presenting the final analysis of interesting insights arising from the studies undertaken.

7.1 Introduction

The purpose of this research has been to better understand designers in order to propose how EcoDesign principles might be better integrated within small product design consultancies. This has been achieved through primary and secondary research that considered the perceptions and behaviour of product designers and their attitudes towards EcoDesign products. Other important stakeholders, especially clients, have also been taken into account along with their interactions with designers. The prototype EcoDesign resource ‘d.eco’ was created to test whether a fresh approach towards changing attitudes and behaviours could be more effective than existing EcoDesign tools.

7.2 Design Brief and Process

The design brief is essential for design and the design process. Having a description or requirements for the finished work before the creative process begins is what differentiates art from design (Archer, 1965). Designers work towards solutions that best fit the brief because it is what ultimately defines the scope of a project (Cross, 2007). The brief is of particular importance when it comes to EcoDesign because having EcoDesign included in the brief ensures that it is not only part of the solution, but that it was considered from the beginning as an intrinsic component of the design process (Sherwin and Bhamra, 1999).

7.2.1 Design Brief

Traditionally a brief was something that was passed down from client to consultancy, but the changing role of design consultancies means that increasingly they are being asked to advise based on their experience with consumers and their understanding of user needs (Feldman and Boult, 2005). This means that clients are expecting to collaborate in the brief creation process, though this does not necessarily mean they
approach SDCs without instructions or guidelines. Much of the interview time during
the main study was devoted to anecdotes critiquing the briefs that SDCs had received,
and experiences of this issue were fairly universal. The root of the problem with bad
briefs is that they are being written by non-designers, who understandably are not
necessarily well versed on what makes a good brief. In addition to this, there are other
mitigating factors, such as being driven by competitor products rather than real needs,
or the vagaries of internal hierarchies within the client company.

Fortunately, even if the initial briefing meeting with a client hails the introduction of a
brief from the client, this is seen as the beginning of a process rather than a fait
accompli. The best briefs seem to be those that both SDC and client feels they have
had a noticeable influence over. Though this may not necessarily mean equal input, as
the interviewees implied that part of the briefing process could be about persuading
clients that what they want is not what they thought they wanted.

However, if this process happens, it can afford SDCs more power over the products
they design than might be first thought. Clearly, there are limitations, but the briefing
process offers a significant opportunity for SDCs to influence the direction of their
design process. Having EcoDesign written into the brief provides significantly more
assurance that it will lead to an EcoDesign product than retrospectively trying to
introduce EcoDesign principles to an already ongoing project. The influence designers
can have on a project diminishes as the product development process progresses, so
the greatest impact can be made if environmental considerations are included right at
the beginning, with the definition of a need.

Designers in SDCs seem to have much more opportunity to influence strategic
decisions than those in larger companies. However, this is still very dependent on
clients, and the level of trust SDCs carry with them.

7.2.2 Design Process

Despite the designers who were interviewed not following a formal product design
process, the methods they described included key elements that are common amongst
many established models of the design process. One of these was the linear iterative
nature of design, a generalised form of this process is shown in Figure 2.8. Another
element was the convergent-divergent (Brown, 2009) nature of design, whether the
designer should be creating choices or making decisions. At various points in the
process there is divergence to create a number of alternatives, and then convergence
as these alternatives are evaluated, and the most promising concept or course of action is selected (Banathy, 1996). Both of these phases are needed, not only to create ideas but also take them to a final solution. This divergent-convergent behaviour, with an overall convergence in design alternatives, is shown in Figure 2.12.

The main differences in the design process were determined by the brief and the needs of the client. In this context, the needs relate to the technical capacities of the client. SDCs could be asked to create anything from concepts to finished products ready to be shipped to distributors of customers. Following the Total Design Activity Model (Pugh, 1990) Figure 2.10, the steps in between are detailed design and manufacture. Where the process finishes for SDCs is important, especially when it comes to employing EcoDesign principles. As one interviewee explained:

“The LG, Sony, Samsung, Panasonic’s of the world will have their actual making rooms or their own infrastructure to do it. So, a lot of the time you are handing back surface data which will then be manipulated. This is why it’s difficult to get a sustainable issue on this because they take it out of your hands pretty quickly and do what they want with it.” (DesV-m)

7.2.3 EcoDesign and Company Ethos

Many of the interviewees comment on the importance of their values and how these influenced the design approach. Although only some were specifically concerned with the environment, there was particular importance placed on having an ethical design approach. A small number of people were against EcoDesign, though for reasons not fundamental to the premise of EcoDesign, more to do with its current execution. The main difficulties were with a poor design using environmental credentials as an excuse for bad products. Alternatively, the issue was more philosophical, relating to the long-term debate over the ghettoization of design approaches. i.e. EcoDesign should not be regarded as a separate approach to design, but rather one of the many considerations included as part of any design process.

Awareness amongst the interviewees was quite general when it came to EcoDesign. Most of them focused on a life cycle approach rather than more abstract propositions like Factor Four (Weizsäcker et al., 1997) and Natural Capitalism (Hawken et al., 1999). Also, there was limited recognition of the breadth of EcoDesign tools available, with LCA software such as SimaPro (PRé Consultants, 2015) and openLCA (GreenDelta,
2006) being most commonly experimented with. Unfortunately, Life Cycle Assessment can be a very complex process to learn, especially when trying to make one off accurate appraisals of products. LCA software can also be quite expensive or depending on their service model, the databases that are essential to run the LCA are expensive, even if the software itself is free. There was a clear association made between this complexity and the ability of designers to make substantiated claims about the environmental credentials of their products. This concern about not being criticised seemed to trump the desire to make more environmentally sound products. This may relate to the adage that, “it is better for reputation to fail conventionally than to succeed unconventionally” (Keynes, 1936, p.158). Though the apprehension is also born out of the genuine issues of time, money and skills that are presented as significant barriers to EcoDesign, as described in Figure 2.16.

Notwithstanding this, there was some early evidence that younger employees in SDCs, or those who had more recently graduated with design degrees, had some foundation in EcoDesign from their studies, and were more confident to engaging in it.

7.2.4 Knowledge Acquisition and Information Sharing

The importance of learning, and acquiring new skills seemed to be a fairly intrinsic part of being a designer from the point of view of the interviewees. This could be best summed up by the following quote:

“My point of view on learning is the day you stop learning; you might as well die.” (DesP-m)

It was clear that even with the plethora of technologies available, designers generally preferred to communicate with people they know and trust. This could be colleagues or contacts when considering design, with more technical questions especially those to do with materials or process being addressed to suppliers and manufacturers. However, this was tempered by the need to balance the speed of access to information, with the level of accuracy available. Given the comparatively short duration of projects, the SDCs were always very aware of the time they had to acquire and apply knowledge and had learnt a series of strategies to deal with this. The internet was an essential part of this process, even though it comes with issues of trust and reliability.
“I mean the predominant way of finding information is through the internet. If we need to find something now, you’re straight on the internet, and you can find an answer.” (DesO-m)

The interviewees looked to find a number of independent sources to triangulate the information or check it against a recognised published source, an expert in the appropriate field or someone they trust. These tactics were generally ad hoc, with very little consistency within each business, let alone across the industry. The main reason for this seemed to be that the SDCs never felt they had enough time to stop and create a proper knowledge acquisition and sharing system, despite being aware that their current systems were inefficient. The suggestion was that if a system existed that was fast, inexpensive and above all could be trusted, SDCs could see a definite benefit in adopting it.

7.3 EcoDesign Tools

Given that SDCs have a degree of control over their briefs, it would seem that there could be more EcoDesign practised in these organisations if the designers were so willing. There was some evidence that the SDCs were amenable to this, but that they did not feel they had enough knowledge to convince indifferent clients to include environmental considerations in their briefs. There are already many EcoDesign tools available, including many free online resources and checklists. The work of Lofthouse (2006) demonstrates that there are many reasons why designers do not use the available tools and in particular that “the slow uptake of ecodesign by product designers is considered to be a result of a lack of appropriate tools” (Lofthouse, 2001). The existing tools do not match the working culture of designers or their creative process (Durling et al., 1996) and there is no one approach that is comprehensive or universally accepted. In addition to these reasons trust and cost were identified by the SDCs studied, they felt that there was no way of knowing if free resources were reliable and if expensive tools would be worthwhile. This quandary had led to inaction unless clients had specifically asked for environmental aspects of a product to be considered or an individual designer was prepared to apply their current knowledge. This combination of reasons has clearly had a significant bearing on the uptake of EcoDesign.
7.3.1 Tool Requirements

When it came to tool requirements the three most salient stipulations were that it be visually engaging using familiar visual language, enables learning by provided positive examples of EcoDesign products and allows communication between designers widening their existing networks. The interviewees were unequivocal that the way information is communicated to them is nearly as important as the information itself. If a resource was not visually engaging, it would undermine this, however useful the other features might be.

“Designers are prejudiced. If it doesn’t look good, they won’t engage. It’s got to be brilliantly visually accessible, completely intuitive, and un-patronizing.” (DesF-m)

Visual engagement was not just about communication but also inspiration. An EcoDesign resource should make designers want to engage with it, “seducing” (DesG-m) them into wanted to learn more.

“First engaging people visually in what’s gonna spark their interest. So you look at it and think, ‘Oh, that looks nice’. And that’s what encourages you to probe further.” (DesF-m)

The importance of the design community sharing of good examples of EcoDesign was made clear in the literature review (Bakker, 1995; Johansson, 2002; Lofthouse, 2017; McAloone, 1998) as well as through the interview process. Designers can learn a number of things from existing products, a not just form and function. If a product has used a particular material or manufacturing process, this tells a designer something about the capabilities of those things and whether the same system or substance might be applicable for their own work.

“The first thing we do is we see how other people do something. If you had to redesign a bike, you would look at existing bikes, and assess what they had been made of and how they were put together.” (DesN-m)
Exemplar products are also a good way of introducing new technologies, or applications of technologies that designers may not find through any other means. In addition to products, having an opportunity to share opinions with other designers helps broaden awareness and validate thoughts around a particular product or innovation.

7.4 Designers are People too

Although there may be something special about the way designers see the world, they are ultimately humans, and prone to the same emotions, attitudes and social norms as everyone else. While this might seem like an obvious point to make, much of design research focuses on what makes designers different and ignores the socio-psychological similarities that we all share. The reason for this is understandable; it is much easier to model behaviour by making three assumptions, see Table 2.1 and Table 2.5, than try to replicate the complexities of real people accurately.

“There are professions more harmful than industrial design, but only very few of them...by creating whole new species of permanent garbage to clutter up the landscape, and by choosing materials and processes that pollute the air we breath [sic], designers have become a very dangerous breed.” (Papanek, 1984, p.ix)

While the words written by Victor Papanek (1984) are quite shocking it is hard to disagree with them when considering product design as a ‘rational actor’. However, product designers are not generally considered social pariahs, nor do they think of themselves in this way (Stevenson et al., 2011b). The reasons for this are complex and exist at both the personal and societal level. One way to view this would be through cognitive dissonance theory (CDT) because there is discord between cognition and behaviour for both designers and consumers. In creating an object that intrinsically has a detrimental effect on the environment, for most responsible designers this would create dissonance between their working lives and how they think of themselves as people. However, this contradiction can be justified or resolved in a number of ways, including:
> Diminish the impact of product – This is just one of millions of different products.

> Relative impact of product – I could have designed something even worse.

> It is what the client wants – This is my job and how I sustain myself and my family.

> Not my responsibility – Customers drive the market, I design what it demands.

> Other people are worse than me – At least I am not designing weapons.

These examples do not result in a change of behaviour; they just change the way design is perceived. A similar process exists for consumers, and as discussed in Section 2.7 the Purchase Rationalization (Davies and Gutsche, 2016) bias exists. Ultimately this means purchase decisions are generally emotionally led and then post-rationalised (Berglund and Matti, 2006; Chatzidakis et al., 2006). Cognitive ease is created by thinking things such as:

> Diminish the impact of product – This is just one of millions of different products.

> Relative impact of product – I have not used a new plastic bag in six months, so I have environmental credit that I can use on this new product.

> Denial of responsibility – The designer/manufacturer should have made this sustainable, and if it is not very sustainable, it is their fault.

> Other people are worse than me – I now only have one of these, my neighbours have three in their house.

> Affordability – I cannot afford to consider the environmental impact of products.

This even extends to issues of labelling or certification. Labelling products in a similar way to some foods are being Fairtrade, will not necessarily environmentally improve consumer behaviour. People like the lack of information on EcoDesign because it allows scope for them to invent the ecological credentials of a product (Davies and Gutsche, 2016). That is not to say that consumers will not ask for better labelling of EcoDesign goods when surveyed, just what they generally do when actually making purchases.
Having said all of the above, not everyone makes poor environmental choices, and there are plenty of people who have autonomous motivation toward the environment. That is to say, people who tend to engage in pro-environmental behaviour because those attitudes and behaviours are integral to their sense of self, or because they find such behaviour inherently satisfying (Lavergne and Pelletier, 2015). Unfortunately, that definition does not describe the researcher or the majority of other people. Equally, it is not impossible to change attitudes and perceptions as long as the approach elicits a change in behaviour, rather than using the quicker and easier cognitive bias shortcut. Getting this approach right is difficult as the issue of manmade climate change has demonstrated. While the scientific consensus and evidence for global warming continues to mount; there has not been an associated change in the number of people who believe in it (Feinberg and Willer, 2011). This apparent anomaly has been attributed to a cognitive bias called the just-world hypothesis, which is when a person believes that the world is inherently just and so that the actions of a person lead to morally fitting consequences (Furnham, 2003). Dire messages aimed at stopping global warming predict that something very bad is going to happen, especially to future generations. This seems extremely unjust, because how could a person, or their innocent unborn grandchildren possibly deserve the impending catastrophe. So, to create cognitive ease the depiction of the forbidding future is discredited. Given this feedback loop, increasingly gloomy predictions only serve to reinforce the denial of the forecast.

Taking all these issues into account, and that they are things that can effect designers, clients and customers it is not so surprising that there are few good examples of EcoDesign products on the market. In the 55 years since the publication of Silent Spring (Carson, 1962) we are still in a position where only just over half of the people in the world believe climate change is caused by human activity, and less than half perceive it as a threat (Pelham, 2009). In this context, it is not so surprising that the rather more recent concept of EcoDesign has not become universally accepted and practised. Below are the main reasons given as barriers to EcoDesign that made up the doughnut chart in Figure 2.16. Most if not all of these could be seen as legitimate reasons for not practising EcoDesign, though many are not insurmountable barriers if the will was there to change. However, they could equally be seen as ways of creating cognitive ease in the minds of designers and their clients.

> Lack of Information, Knowledge, Skills or Tools
Designers, their clients and customers are dependent upon one another (Charman, 2013). The simplest of these co-dependencies is that users cannot buy something that has not been designed, and designers cannot design and market something that consumers do not want or do not know they want. However, this dichotomy is broken every time an innovative product comes to market, and this needs a chief executive officer or equivalent person responsible for taking managerial decisions to back the idea. In the context of SDCs, this means that those running the businesses and bringing in work have to believe that their designers are capable of designing successful EcoDesign products and that they can persuade clients to accept and manufacture those ideas. This is clearly not happening in more than a few areas, and the creation of existing EcoDesign tools has not facilitated this sufficiently thus far.

### 7.5 d.eco: Normalising EcoDesign

The d.eco EcoDesign resource was created in part to normalise EcoDesign. So, rather than being considered a fringe activity, it becomes an intrinsic component of every design process. Normalisation and associated confirmation bias is important as it affects behaviour, as shown in Figure 2.19. Also, the more times EcoDesign is practised, the more the activity becomes normalised and thus likely to be employed in the future. This normalisation goes hand-in-hand with building awareness of good existing examples of EcoDesign. This was discussed in Section 7.3.1, and that it forms an important part of the learning process for designers. However, for this to work, those using d.eco have to trust that what they are seeing represent truly good examples of
EcoDesign. They are likely to be confident in being able to judge what they consider good design but may be unclear about the environmental credentials of what they are looking at. There was uncertainty on whether the ‘wisdom of the crowd’ would be enough to guarantee reliability, especially if the opinion of non-professionals is included. Crowds can be irrational as well as wise, so Oinas-Kukkonen (2008) proposed four key criteria for establishing a wise crowd. There should be i) diversity and ii) independence of opinion, with each user having their own separately formed point of view. Users should be able to iii) specialise and draw upon their own local knowledge. Finally iv) there needs to be a mechanism for turning private judgements into a collective opinion. This means that there needs to be sufficient diverse and independent users of d.eco before the aggregated opinions of stories can be considered valid. There is no specific number of necessary users that can be quoted because it is the type of users as well as the total number of users that matters. When d.eco is being established, having expert curators may be an option, so that it is sufficiently useful for designers for a critical mass of user to accumulate. Alternatively, there would probably need to be a significant investment in populating and ranking stories on d.eco before it is launched.

The reliability issues discussed above were the main aspect of d.eco where participants raised concerns. The visual engagement and communication of d.eco was generally praised, it may not have had design ‘magic’ but was sufficiently good to demonstrate the importance of this facet of the resource. Using Axure as a research tool was an integral part of conducting the study, but many of the limitations of d.eco could be easily rectified if it were turned over to a web designer to create a proper website, rather than a wireframe prototype. This is also the case for the suggested changes that came at the end of the study. However, one additional aspect was the inclusion of editorial space for expert viewpoints to be heard. When d.eco was being conceived the assumption would be that there would be no real curation once it was setup. However, it was clear from the evaluation study that users felt a level of expert intervention would be essential for them to trust the site fully.

7.5.1 Limitations

It is not possible to definitively say whether d.eco would meet all the design requirements because of the time restrictions on the project. The following elements
would have required significantly more time to refine and populate d.eco as well as longer testing period.

> Rather than just offering an evaluation of concepts at the end, the resource needs to provide support at different stages of the PDP

To be sure that this requirement was met would have required feedback on d.eco through its use in a live design project. However, this would not just mean testing for the duration of a project, because there is the necessary normalisation time. d.eco is not a tool, like a pair of trainers, which can picked up when needed, it is more akin to gym membership (but much more enjoyable and inspiring). d.eco is part of the daily routine that designers have when they want to be kept abreast of what is happening in design and EcoDesign. A longer duration would have enabled a longitudinal study, where the impact of d.eco could be measured over time. However, this would have required a much more advanced version of d.eco and longer test periods. This type of study could have added years to the research process, so was deemed impractical for doctoral research, but could be pursued as part of a future research project.

The following requirement is also limited by the normalisation period, as well as by the user base.

> d.eco expands the current professional and personal networks that designers can access by providing an online social networking service (SNS) that enables a worldwide connection to people who share similar interests. This expands on the existing practice of connecting with people within the industry when looking for trustworthy sources of information.

The d.eco prototype was self-contained, so there was no way for users to actually create a network with other users. However, as discussed in Chapter 6, there are numerous existing examples of this type of network. As with other aspects of d.eco, integration of tried and tested elements that the users are already familiar is preferable. As was suggested by one of the participants, signing into d.eco with existing Facebook or Google accounts is a workable option.

7.6 Driving EcoDesign Forward

The success factors for EcoDesign derived from the literature review and communicated in Table 2.3 (Johansson, 2002, p.105) were as follows:
> Commitment and Support are Provided by Management
> The Environmental Considerations are Addressed as Business Issues
> Companies Train their Customers in Environmental Issues
> Environmental Issues are Integrated into the Conventional Product Development Process
> Environmental Checkpoints, Reviews and Milestone Questions are Introduced into the Product Development Process
> An Environmental Specialist Supports the Development Activities
> Examples of Good Design Solutions are Utilised
> An Environmental Champion Exists

In some ways, these success factor, much like the drivers in Figure 2.17 are descriptors of the conditions that need to be in place for EcoDesign to thrive, rather than instructions on how to get there. From the point of view of an individual designer, many of the factors listed above are outside of their sphere of influence. Again the authority of a chief executive officer or equivalent needs to be involved in this process unless the SDC only has a few employees and the hierarchy is much flatter. An individual designer would struggle to unilaterally make these changes, but they may be able to initiate change. Movements necessarily start with individuals, so the first step in change always begins with people. Section 7.4 discusses how individual cognitive biases need to be overcome in order to change behaviour and Section 7.5 examines the means that d.eco proposes to achieve this. The next step is to spread things wider, which in essence is done by word-of-mouth, clicks on the social networking service, or sharing links to d.eco (or its successor). The most important part of this process is that the initial designer(s) is confident in the potential success of taking an EcoDesign approach and can convey this assuredness to their colleagues, superiors and ultimately clients.
8. CONCLUSIONS AND FURTHER WORK

This chapter draws together the conclusions reached from the work presented in this thesis. It reflects on how the aim and objectives have been met and presents the contribution to knowledge made by this study. The limitations of the work and recommendations for future research are discussed at the end of the chapter.

8.1 Meeting the Aims and Objectives

This section details the research activities as carried out within this thesis, describing how they fulfil the objectives of the research aim to investigate ways to increase the integration of EcoDesign principles within small product design consultancies.

Objective 1: To determine current practice and critically review the use of EcoDesign tools in industry.

This objective was accomplished with a comprehensive review of literature presented in Chapter 2 as well as the study of small design consultancies described in Chapter 4. In order to do this, it was important to understand small design consultancies and how they differ from larger design teams and in particular their relationship with clients and how this affects their product design process. The design process has been written about extensively, and an in-depth understanding of these publications was developed so that it could be compared with the observations made during the study of SDCs. A similar approach was taken with EcoDesign, there are two decades worth of writings on this subject, though not necessarily focusing on design consultancies, which could be compared with the empirical study of designers working in SDCs.

Objective 2: To identify the limitations of existing tools and why they are not more widely used.

To achieve this objective, a similar process was used as for Objective 1. The issue of EcoDesign tools and whether they are being used in design practice has formed the topic of previous studies, and their findings are available in the literature. However, this body of work is not as extensive, and the previous focus has not been directed towards design consultancies. So, part of the approach was to compare and contrast the existing literature with the primary research to see whether it could be applied more broadly across design teams of various sizes. Another aspect of the literature review
focused on considering designers as people and the social-psychological aspects that affect them as much as anyone else in society. This provided some useful insights into why EcoDesign tools are not used more widely, as well as why designers say they are not more widespread.

**Objective 3: To understand the needs and aspirations of product designers when undertaking EcoDesign.**

This objective was achieved in two parts, initially through the Chapter 4 main study which devoted significant time to understanding how the participants and their organisations currently build skills and knowledge. This knowledge was then used in the creation of the d.eco online resource. Through the development, testing and evaluation of d.eco, shown in Chapter 6, the specifics of how this understanding related to EcoDesign was developed further.

**Objective 4: To develop the requirements for an EcoDesign resource that has the potential to overcome these limitations.**

The requirements for d.eco are listed in Section 5.2.1. Whilst the existing literature was taken into account when creating the requirements; they were heavily based on the findings of the Chapter 4 main study. This was because the participants were not necessarily comparable with those investigated by other people, but also because there were more plenteous and nuanced findings from the empirical study. This is not to say that other research projects have not found similarly rich results, rather than the limitations of journal article word limits restrict what can be conveyed in those discourses. The responses from the main study were meticulously analysed, and this led to many fruitful insights that were then used to create the resource requirements.

**Objective 5: To create a prototype resource and refine it through an iterative process of user trials, modification and re-testing.**

The way this objective was met is described in Chapters 5 and 6. A novel approach was taken in creating the resource. Axure RP Pro (2015) was used to prototype the d.eco website resource. Axure allows high functioning web prototypes to be created without the need for coding. Its in-built wireframe, widget and conditional logic capabilities provided much need functionality in the prototype. Given some of the requirements developed from the primary research, it would have proved very difficult to implement
and test these without such software. The Axure Share server meant that d.eco could be published to the internet, and users could access it like any other website testing. This accessibility and the underlying functionality of Axure meant that it was comparatively easy to make it available for testing, receive feedback, make changes and then re-test without making any fundamental changes to the resource. The realism that Axure offers meant that fewer caveats needed to be given before testing, and participants were able to experiment with d.eco in their own time and reflect on this with relatively little interference from the researcher.

### 8.2 Overall Conclusions

The reason that there is not more EcoDesign being practised in small design consultancies is not due to a lack of EcoDesign tools. There are numerous EcoDesign tools, methods, frameworks, checklists and guidelines, but they are not widely used by the type of designers considered in this research. The overabundance of tools is part of the problem because it can overwhelm someone new to the topic, and there is no one approach that is comprehensive or universally accepted. In addition, there is a level of investment needed to learn how to use the tools. This is a genuine barrier that may be reduced by the increasing levels of sustainable design being taught to undergraduate designers. There is also the added socio-psychological barrier, and the need for cognitive ease. As discussed in Section 2.7 there are a number of complex issues associated with the anxiety around climate change and the impact of product creation. When added to the commercial trepidation about unconventional processes and innovation, “it is better for reputation to fail conventionally than to succeed unconventionally”, the lack of available EcoDesign products becomes less surprising.

One of the most unexpected discoveries from conducting interviews at SDCs was their almost non-existent knowledge of laws, directives and standards that cover the ecological aspect of products. Things have developed since those interviews were conducted, and introduction periods have ended, meaning the rules are now fully in force. Another reason for this lack of awareness was due to the relationship SDCs have with their clients. Designs are often passed from SDCs back to in-house teams before the regulations have to be applied. This is not ideal but reflects the reality of the designers that were interviewed.

The designers in this research experienced briefs of varying length, from one word to many pages, but very rarely did they have an environmental agenda. It was clear from
the main study interviews that the design process and brief formulation did not match what is traditionally taught to undergraduate designers. Both the literature review and the interviews revealed that there are innumerable models of the design process and very little agreement over which is most accurate. In the case of SDCs, their briefs are generally the result of collaborative action rather than a top-down process. This is important because it provides an opportunity for designers to influence their briefs and hence the potential for the inclusion of EcoDesign principles.

The designers were very unlikely to use books, or other printed documents to learn about developments in design. Their main sources of information were colleagues and others in their networks, such as suppliers, or the internet. Most of the interviewees had a time in their day where they browsed popular design websites such as Dezeen and Core77, this reflected their interest in design beyond their own work, and also that they habitually engage with an online source of design news. Some interest was shown in online social bookmarking and that it would be useful to allow designers to collaborate.

Although it was established that SDCs have some control over their briefs and are in a position to influence their clients, they did not currently have the confidence to include ecological principles in their design process. The reasons for this are discussed above. There were some very frank responses from the interviewees when it came to asking about the requirements they might have for an EcoDesign resource. “Designers are prejudiced. If it doesn’t look good, they won’t engage.” (DesF-m). This was considered a gateway requirement, and everything followed on from there. The requirements created in Section 5.2.1 are unlike those of most other resources. After visual engagement, the opportunity to learn through the study of existing examples of work was a consistent theme, and this forms a major facet of the way designers learn. Another criterion is that the resource should provide a space to develop confidence in EcoDesign issues. The way d.eco has been created it does allow for users to observe before they directly engage with the wider community. Discourse is likely to lead better learning, but initially, this is not essential, and users can acclimatize, learning in their own way and at their own pace.

Testing of d.eco led to several conclusions. d.eco was considered to be visually engaging, and the respondents reaffirmed the importance of this aspect of the resource. The most positive response was to how useful d.eco could be in highlighting inspirational EcoDesign stories. The only caveat to this was that to remain inspirational the content would need to be extensive and self-sustaining. Accountability was the area
of most concern for participants and whether they could trust the knowledge of other users. The overall opinion of d.eco was that it could be useful or very useful in the promotion EcoDesign within small design consultancies.

### 8.3 Contribution to Knowledge

As the literature review shows, there is no shortage of EcoDesign tools available to designers. So it was necessary to take a distinct approach in trying to understand why with all of these EcoDesign tools they are not more widely used. Psychological models have been used before in design research, but they are normally applied to the user, not the designer. By acknowledging that designers are no more ‘rational actors’ than anyone else it was possible to see the participants as people in all their flawed glory, rather than as some abstract being called a ‘designer’. Put simply; designers are human too. Having done this, the application cognitive dissonance theory afforded a better understanding of the behaviour of designers and how this interrelates to the product design process. Knowing that cognitive biases are a significant barrier to the adoption of EcoDesign principles and the creation of sustainable products offers a new approach to changing the way in which products are created.

There are elements of the research approach that are novel. As part of the effort to find visual ways to depict complex data, the Clustering Matrix (Kumar, 2013) was found. Although heat matrices are a well-established data visualisation tool, they have not been used to cluster qualitative data as part of the coding and clustering process before. Given the large number of initial codes, it was difficult to be certain of how comprehensive the splitting and splicing process had been. In many research projects, this issue would have been easily tackled by involving several people in the data analysis process. However, this is not possible in doctoral research as it cannot be a collaborative process. Furthermore, they may be other situations where an individual Research Associate or similar academic does not have the resources to involve other people in the part of the process. Creating a Clustering Matrix and using statistical algorithms to rapidly sort complex data could be an incredibly useful tool for all kinds of qualitative research.

d.eco is not a finished and fully functional EcoDesign resource, but it does represent a different approach to tools as well as research. Although Axure is ostensibly a website prototyping tool, it offers more than this, in particular when it comes to the conditional logic capabilities of the software. This creates a testbed that can be adapted to serve
many purposes. With online access for participants, across platforms, and the ability to be easily modified in response to feedback makes this a powerful research tool. It could be considered to offer some of the advantages provided by quantitative research, in terms of administering a study. However, as demonstrated in this research, traditional qualitative research approaches were still required in the initial stages of the project. The d.eco approach supplements existing data collection techniques, rather than replacing them.

8.4 Limitations of the Research

Whilst this research has made significant contributions to knowledge; it inevitably has some limitations.

As discussed in Section 7.5.1, the nature of the research outcomes have transcended the scope of a doctoral research project. To truly validate d.eco it would require participants to have extended exposure to it. This would necessitate a longitudinal study of significant length in order to draw definitive conclusions, especially if looking for residual effects on behaviour change.

Although much time was spent in recruiting the right participants, making sure that they fit the necessary criteria of the study, there was ultimately a limited choice because involvement is dependent upon the agreement of the participant. So, in that sense they are self-selecting. While they may have met the criteria of the research, the fact that they agreed to take part may say something about their predisposition for trying new things, or their interest in EcoDesign. All of which means that generalisability of this study is limited. Further testing would be required to test the efficacy of d.eco amongst the wider product design community.

8.5 Further Work

Based on the contributions to knowledge a number of unrelated projects could be conducted based on the use of Clustering Matrices and Axure. However, putting those aside there is an opportunity for direct follow on research from this study.

As discussed in Section 6.3.6, the first steps would be to instigate the suggestions made in the last evaluation of d.eco. In addition to this, there may need to be a rethink of research strategy in order to reframe the research as a longitudinal study. The main aim of such a study would be to see if there is a measurable increase in confidence around
the EcoDesign for those who engage with it over a set period of time. A follow up for this might be to see if the boost in confidence persists even when d.eco is no longer being used.

A separate study, but one that also builds on this research might be around cognitive biases. A direct study that aims to identify all the cognitive biases experienced by product designers could be very enlightening. This type of study would also benefit from a cross-disciplinary team, something that is not really possible for a doctoral study. Having other researchers involved especially from a psychology discipline could only work to enrich the findings of the study.
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SAGE.
Appendix A: The Context of Design Consultants

Appendix B: Embedding Sustainability into New Product Development


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Improving the product:
- Introducing product enhancements and improvements that align with sustainability goals.
- Conducting thorough research to understand customer needs and preferences.
- Incorporating sustainable materials and processes into the product design.
- Developing partnerships with suppliers to ensure ethical sourcing.
- Testing prototypes with environmental and social impact assessments.

---

Sustainability and new product development:
- Conducting market research to identify sustainability trends.
- Developing a sustainability strategy that aligns with company values.
- Creating a product development process that integrates sustainability considerations.
- Establishing partnerships with other companies to share sustainability practices.
- Conducting life cycle assessments to understand the environmental impact of the product.

---

Business case:
- Identifying the financial benefits of sustainability in new product development.
- Estimating the potential savings from incorporating sustainable practices.
- Assessing the impact of sustainability on customer satisfaction and loyalty.
- Evaluating the potential risks associated with sustainability initiatives.
- Developing a sustainability plan that aligns with company goals.

---

Scoping:
- Defining the boundaries of the sustainability scope.
- Identifying the key stakeholders and their interests.
- Establishing key performance indicators (KPIs) for sustainability.
- Developing a sustainability strategy that aligns with company values.
- Conducting a sustainability gap analysis to identify areas for improvement.

---

Appendix A: Sustainability Glossary

- Key sustainability terms and definitions.
- Sustainability metrics and indicators.
- Sustainability strategies and practices.
- Sustainability case studies and examples.
- Sustainability tools and resources.

---

Postscript:
- Reflecting on the importance of sustainability in new product development.
- Emphasizing the need for collaboration and innovation in sustainability initiatives.
- Highlighting the role of sustainability in driving business success.
- Encouraging companies to adopt a sustainability mindset.
- Inspiring future sustainability initiatives and projects.
Appendix C: Barriers and Driver of EcoDesign

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Appendices
Appendices

Appendix D: Legislation, Directives and Standards

The Packaging Directive (Council of the European Union, 1994) is concerned with minimising the creation of packaging waste material and promotes energy recovery, re-use and recycling of packaging. It sets targets for packaging waste, and the level of packaging that should be recycled by Member States. When the Directive was revised in 2004 it increased the recycling targets to be met by the end of 2008. Most of the EU are expected to recover 60% of packaging waste and recycle 55% to 80%. The amended Directive sets material specific recycling targets by weight such as 60% of paper, board and glass, 50% of metals and 22.5% of plastics. Some new Member States have until 2015 to meet these targets.

Volatile Organic Compounds (1999)
VOCs emissions are caused by organic solvents such as those used in paint, varnish and industrial cleaning fluid. The Directive (Council of the European Union, 1999) covers emissions from stationary commercial sources, and has been mandatory since 2007. Companies either have to install equipment to comply with the emissions limit or replace conventional products with low solvent or solvent free alternatives.

The ELV (Council of the European Union, 2000) establishes standards for recovering materials from scrapped vehicles. Article 7 requires a reuse and recovery target of 80% by 1 January 2006, increasing to 85%, by weight, in 2015. The directive aims to raise the standard and take-up of vehicle dismantling and recycling. By making vehicle manufactures responsible for the costs of implementation the EU hopes to push them to create more environmentally friendly vehicles.

The RoHS (Council of the European Union, 2003a) restricts the use of certain hazardous substances in electrical and electronic equipment. It aims to limit the environmental impact of these products when they reach the end of their life. It bans or restricts the
use of dangerous substances like Cadmium, Mercury and Lead in electrical equipment. There are some exemptions such as the use of Mercury in compact fluorescent lamps.

Waste Electrical and Electronic Equipment (2002)

The WEEE Directive (Council of the European Union, 2003b) aims to encourage the design and production of electrical and electronic equipment which take into full account and facilitate their repair, possible upgrading, reuse, disassembly and recycling (WEEE, 2002). It makes manufacturers responsible for the recovery, dismantling and recycling of electronic equipment at its end of life. The Directive has been in force since 2007 and stricter targets are being set by the EU over time. Currently the required recovery rate of appliances, by average weight, is 70% to 80% depending on the type of equipment. The rate of component, material and substance reuse and recycling is between 50% and 80%. Electrical and electronic equipment should be marked with a crossed out wheeled bin symbol either on the product or the packaging. This symbol aims to encourage consumers to discard this waste separately from other household rubbish.


The EuP (Council of the European Union, 2005) establishes parameters for designing products that use energy, though not all energy-using products will have obligations under the framework. It is different from older directives because it does not only focus on end-of-life. Manufacturers will have to look at the whole life cycle of their product and in particular consider: raw material selection and use; manufacturing; packaging, transport, and distribution; installation and maintenance; use; end-of-life (European Union, 2005).


The Batteries Directive (Council of the European Union, 2006a) aims to improve the environmental performance of batteries and accumulators (capacitors, rechargeable batteries, etc.) throughout their life cycle. In particular to reduce their number in general waste by encouraging their separation and recycling.
Appendices

Registration, Evaluation, Authorisation & Restriction of Chemical Substances (2006)

The REACH legislation (Council of the European Union, 2006b) replaces a number of European Directives and Regulations with a single system. It came into force in 2007, to be phased in over a period of eleven years. The regulations include provision for the testing of chemicals, which includes metals, and substances for their effects on the environment and human health. Responsibility is also put on manufacturers to reduce the risk from chemicals and find alternatives for the most dangerous substances. The legislation requires that all chemicals on a list of around 30,000 that are consumed, processed, produced or traded in quantities of one tonne or more per year in volume must be registered with the European Chemicals Agency. To register details of the properties and risks associated with the chemical must be provided. Steps taken to reduce any hazards must also be included.

International Standard Organization (ISO)

The ISO 14000 series defines a group of standards all under the general heading of environmental management systems (Whitelaw, 2004). ISO 14001 (ISO, 2004), 14025 (ISO, 2006a), 14040 (ISO, 2006b), 14050 (ISO, 2009) and ISO/TR 14062 (ISO, 2002) are of particular interest to designers. Standards are not legally binding like the laws described above, their aim is bring uniform practice into industry and create a benchmark to compare corporations (Ashby, 2009).

British Standards Institution (BSI)

Despite its name the BSI Group operates worldwide, but British Standards are mainly employed in the United Kingdom. The measures most relevant to designers are BS 8871-1 (BSI, 2006) and BS 8887-2 (BSI, 2009). These reference and sometimes specify the use of relevant ISO standards, such as those given above.
Appendix E: Interview Study Ethical Documentation

Participant Information Sheet

The Practice of EcoDesign: A Study of Product Design Consultancies
Participant Information Sheet

Richard Mawle
Loughborough Design School
Bridgeman Centre
Loughborough University
Loughborough LE11 3TU
tel: 01509 228321
email: R.G.Mawle@lboro.ac.uk

What is the purpose of the study?
The aim of this study is to gain a better understanding of how design practices work, their company ethos, design process and why EcoDesign tools are not being more widely used.

Who is doing this research and why?
The research is being conducted by Richard Mawle and forms part of his PhD investigation into EcoDesign practice.

Once I take part, can I change my mind?
You can withdraw at any time, for any reason and you will not be asked to explain your reasons for withdrawing. After you have read this information and asked any questions you may have we will ask you to complete an Informed Consent Form, however if at any time you wish to withdraw from the study please just contact Richard Mawle.

How long will it take?
The interview should take approximately 45 minutes. Any follow-up investigations will only be carried out with further consent.

Will my taking part in this study be kept confidential?
All information on participants be treated as confidential and will be coded/anonymised unless otherwise agreed in advance. Any reference to people or organizations will also be removed.

What will happen to the results of the study?
All audio recordings will be destroyed once the PhD has been completed, which is expected to be by the end of 2011.

I have some more questions who should I contact?
Richard Mawle, Loughborough Design School, Bridgeman Centre, Loughborough University,
Loughborough, LE11 3TU, tel: 01509 228321 email: R.G.Mawle@lboro.ac.uk

What if I am not happy with how the research was conducted?
Loughborough University has a policy relating to Research Misconduct and Whistle Blowing which is available online at: http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing2.htm
Informed Consent Form

The Practice of EcoDesign: A Study of Product Design Consultancies

INFORMED CONSENT FORM
(to be completed after Participant Information Sheet has been read)

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethics Approvals (Human Participants) Sub-Committee:
http://www.lboro.ac.uk/committees/ethics-approvals-human-participants

I have read and understood the information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless (under the statutory obligations of the agencies which the researchers are working with), it is judged that confidentiality will have to be breached for the safety of the participant or others.

I agree to participate in this study.

Your name ________________________

Your signature ________________________

Signature of investigator ________________________

Date ________________________
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Appendix G: Pilot Study Interview Documents

PILOT STUDY

Interview Questions

i. How does the briefing process work?

- BRIEF = MINIMAL
- MEETING = CONVERSATION
- 25 MORE BRIEF-MAKERS
- MEETING = CONVERSATION

SUSTAINABLE = NEVER MAIN ISSUE, BUT PART
HERE.

HERE.

ii. How does company find information?

- MATERIAL CONVERSATION
- GATHER INFO FROM SUPPLIERS
- MATERIALS = MORE IMPORTANT
- ONLINE / PHONE

- COMPLEXITY MORE IMPORTANT
- MAIN MATERIAL

- ELECTRIC
- SUPPLIERS - ASK COLLEAGUES
- SOFTWARE - OUTSIDE EXPERT

iii. How do you judge reliability of information?

- RELIABLE BRIEF SAVES SYSTEM - CONSUMER
- BASIC SPREAD SHEET - EASY TO USE
- 20-30 QUESTIONS, INTEGRATE

- BRIEF IS MADE ADVISORY - CAN BE INFO

- CREDITS MUST, GUY - PULL-IN FOR
- SOLO WORK, GRANTEE APPROVED
- GREEN PEAK APPROVED.
PILOT STUDY

Interview Questions

1) How does the briefing process work?
   2) Do you ever have EcoDesign briefs?

1) How does company find information?
   2) What sort of tools do you use? (Internet, Experts, Books, Suppliers, Software)
   2) What cost would you be prepared to pay?
   3) What would you like to use to find information?
      4) Would you like an Eco tool?
   4) What sort of tool would you like? (Low Cost, Simple, Integrated)

1) How do you judge reliability of information?
Appendix H: Main Study Interview Documents

MAIN STUDY

Interview Questions
How does your company work?
- Introduction/description of business - Products, History, etc.
- How is the company structured? - Size, Hierarchy, etc.
- Is there a company ethos? Top down or collective.

What is the company product design process (PDP)?
- Who sets briefs?
- How are briefs created?
- How much influence do designers have over brief?
- Who is involved in PDP?

How does company learn?
- Who do you learn from?
- Do you share information internally?
- Do you pay for information?
- What kind of online sources do designers consider reliable?
- Which tools do you use, if any, and do any of them consider EcoDesign?
- What would make you want to use tools?

What does EcoDesign mean to you?
- Have you ever designed an Eco Product?
  - If YES - What is an example of EcoDesign projects carried out?
  - Why was this done: client, internal, etc.?

  - If NO - What is a good Eco Product on the market, and why?
  - Why don’t design briefs have an EcoDesign agenda?
  - What are barriers to EcoDesign?
  - What would encourage you to do EcoDesign?
  - How and when could EcoDesign be integrated into PDP?

What do you know about Eco Laws?
- WEEE (Waste Electrical and Electronic Equipment)
- EuP (Energy-using Products Directive)
- RoHS (Restriction of Hazardous Substances Directive)
- Packaging and Packaging Waste Directive
- Batteries and Accumulators and Waste Batteries and Accumulators Directive
Appendices

Interview Questions

How does your company work?
- Introduction/description of business - Products, History, etc.
- How is the company structured? - Size, Hierarchy, etc.
- Is there a company ethos? Top down or collective.
- What is the company product design process (PDP)?
  - Who sets briefs?
  - How are briefs created?
  - How much influence do designers have over brief?
  - Who is involved in PDP?
  - How does company learn?
  - Who do you learn from?
  - Do you share information internally?
  - Do you pay for information?
  - What kind of online sources do designers consider reliable?
  - Which tools do you use, if any, and do any of them consider EcoDesign?
  - What would make you want to use tools?
  - What does EcoDesign mean to you?
  - Have you ever designed an Eco Product?
  - If YES - What is an example of EcoDesign projects carried out?
  - Why was this done: client, internal, etc.?
  - MINIMISE COST
  - MAXIMISE LIFE
  - If NO - What is a good Eco Product on the market, and why?
  - Why don’t design briefs have an EcoDesign agenda?
  - What are barriers to EcoDesign?
  - What would encourage you to do EcoDesign?
  - How and when could EcoDesign be integrated into PDP?

What do you know about Eco Laws?
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- Batteries and Accumulators and Waste Batteries and Accumulators Directive
Appendix I: Details of Questionnaire Participants

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Appendix J: Resource Evaluation Survey Documents

d.eco Testing Instruction Sheet

*NEW*

**WORLD** reflects the combined decisions of all the registered members. Communities, such as Product or Architecture, display the judgments made by this group, and Personal indicates the individual views of the user. **WORLD** is a prototype website, so only the **WORLD** page is shown.

---

**Log In**

www.ecodesign.org.uk

---

**Top Stories in World**

When sustainability topics are selected for a given story this affects its positions in the **Top Stories in World** section. However, there is not a direct correlation with the choices of the individual, because the site replicates the combined effect of decisions made by other users in the **WORLD**.

---

The top left box in ‘Top Stories’ replicates how new stories would be added. You can modify the text, and pick an image, but clicking ‘Submit’ will not actually add a new story in this prototype.

*NEW*
d.eco Testing Email Instructions

Richard Mawle

From: Richard Mawle
Sent: 19 August 2015
To: RE: EcoDesign Research
Attachments: d.eco.instructions.pdf

Thank you for agreeing to take part in the testing of the d.eco website ecodesign.org.uk.

d.eco is an (eco)design news and social networking website where registered members can add ‘Stories’, similar to an online bulletin board. By making decisions on the relevance of sustainability topics covered by a story it can be moved to the TOP STORIES IN WORLD section, where its position moves up or down depending on its level of approval. In addition, the more interest there is in a story, the larger its image appears on the site.

Please have a look at the attached instructions (d.eco.Instructions.pdf) before testing d.eco and completing the associated questionnaire.

Most (but not all) of the links on the page work, so if you click a title, like ‘Throwback Thursday: John Whitney’s Animated Computer Visualizations From the ‘60s’ it will take you to the relevant website. Also, you can make choices about the relevance of sustainability topics covered by a story in its ‘Info’ tab by clicking on Packaging, Length of Life, Production Energy, Material Selection, Impact of Use and/or End of Life.

(For the purposes of the prototype, the comments boxes all contain the same generic text.)

Having tried out ecodesign.org.uk, I would be grateful if you could complete the online feedback survey that can be found here. The survey should only take around 15-20 minutes to complete. Within the survey there are five questions that ask you to explain your response to certain aspects of the d.eco website. The richer your replies are here the more helpful they will be (whether positive or negative). All of the information you provide will be treated in strict confidence, will be kept anonymous and confidential, and will only be used for research purposes.

If you have any questions, please contact me via r.q.mawle@lboro.ac.uk.

Thank you very much for your time, your input will provide indispensable feedback for the d.eco prototype website.

All the best, Richard

Richard Mawle
Sustainable Design Research Group
Loughborough Design School, LDF 1.20
Loughborough University, LE11 3TU, UK

Tel +44 (0)1509 228321
Mob +44 (0)7989 572236
Twitter @RichardMawle @lborodesign

Loughborough Design School - Inspiring Design
www.lboro.ac.uk/lds/staff/phil/richard-mawle.html

Smartphone Login
TOP STORIES IN WORLD

- Blee Halligan's Triptych house extension catches sunlight from three directions
- Throwback Thursday: John Whitney's Animated Computer Visualizations From the '60s
- Family of candle holders created by Simon Legald for Normann Copenhagen

LATEST STORIES IN WORLD

- White buildings sink into the landscape at the Wolf Hotel by AND-RE
- Monochrome marble tableware designed by Bethan Gray
d.eco Survey Questions

1. Introduction

Thank you for agreeing to take part in this survey. Your input will provide indispensable feedback for the d.eco prototype website, and help inform the future development of EcoDesign tools.

It would be beneficial if you spent some time looking at the d.eco website (www.ecodesign.org.uk) before you start answering the questionnaire. However, you may find it useful to have it open in your browser at the same time as this survey.

The survey should only take around 15-20 minutes to complete. All of the information you provide will be treated in strict confidence, will be kept anonymous and confidential, and will only be used for research purposes. There is no obligation for you to complete the survey. If you feel unable to answer some of the questions, or would like more information, please contact Richard Mawer via r.g.mawer@lboro.ac.uk.

Please click ‘Next’ to begin

2. Your Information

The questions on this page are about you.

All of the information you provide is completely confidential and will only be used for research purposes.

1. What is your name?

2. What is your job title?

3. How many years of design experience do you have?

4. Where is your company located?

5. About how many employees work at your company?
Appendices

3. Visual Engagement

The questions on this page are about the level of visual engagement d.eco provides.

**1. Please indicate how visually engaging you find d.eco.**

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</table>

**2. In your own words, please explain if you think d.eco is visually engaging and whether this would influence your use of the website.**


4. Inspiration

The questions on this page are related to inspirational impact of d.eco.

**1. Please indicate how useful d.eco could be in highlighting inspirational EcoDesign stories.**

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<tbody>
<tr>
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</tr>
</tbody>
</table>

**2. In your own words, please explain how you think d.eco might inspire you to incorporate EcoDesign into your work.**


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5. Communication

The questions on this page are related to the way d.eco communicates information.

* 1. Please indicate how effective d.eco is at communicating information about EcoDesign.

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<th>Very effective</th>
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* 2. Please explain how effective the format used in d.eco is at communicating EcoDesign principles, and showcasing products created using these guidelines.

6. Accountability

d.eco uses the collective opinion of the subscribers to judge the importance of articles. The questions on this page relate to the reliability of information provided by d.eco.

* 1. Please indicate how reliable you consider the information provided by d.eco would be.

<table>
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* 2. In your own words, please explain whether using the collective opinion of d.eco subscribers engenders a level of trust in the importance and/or information provided in articles.
7. Overall Opinion

The questions on this page relate to your overall response to d.eco.

1. Please indicate how useful you think the principles demonstrated in d.eco could be in promoting EcoDesign.

   Not useful at all  Not useful  Neutral  Useful  Very Useful

2. Please give your overall opinion of d.eco, and whether you think it might be a useful tool for promoting EcoDesign.

8. Thank You

Thank you for your time.

If you have any comments, questions, or concerns, please contact Richard Mawte via r.g.mawte@boro.ac.uk or leave a message in the box below.

1. Would you be willing to be contacted for a follow up interview?
   ○ Yes
   ○ No

2. At what email address would you like to be contacted?

3. Do you have any other comments, questions, or concerns?
Appendix K: Sample Interview Transcripts

Transcript of interview with DesW-m conducted on 15/02/2011 at ComS-m

Below is a sample of a transcript on an interview conducted as part of the Main Study. To maintain confidentiality names and places have been replaced with the codes described in Appendix F.

RM - DesQ-m put me on to you, and in particular he was talking about that you’d been off to India, and that basically people want to consume stuff, whatever you do; so potentially what you could do was provide people with stuff to consume that has quite a low impact, for fun, and then have other products that potentially last a long time and are useful.

DesWm - Yeah, this was... that was kind of... yeah, where we’d got to when we came back, although it... then it wasn’t... and we didn’t end up pursuing it as a direction for the project, but yeah, I guess we still think its broadly true, I guess. But, yeah, like consumerism isn’t going to go away probably. But the people that did a nice... do you know about the... I assume you’ve spoken to ComQ-m, because yeah they did... well actually yeah DesT-m did like two projects that were sort of again in similar thinking, and probably kind of similar to what we’d have done if we’d gone down that road, I guess, in terms of, yeah, looking at how you might disemboby, I guess, a lot of what you get from a consumer product, I guess; and so design products that are... have an appropriate impact, I guess, for what they are and how they’re used; so I think, ‘cos yeah, you don’t necessarily want to be designing everything to last forever.

RM - And what the sort of genesis of this, and what started you along this path?

DesWm - It was an IDE group project. We did it in 2008/9, I guess, and it... but the three of us that were doing it, we had quite an interest sustainable design, generally, but also it was the beginning of the credit crunch or the middle of it maybe; so it seemed like a... the kind of... the word that seemed to catch both of those world, I guess, was scarcity. And we were going through all the climate forecasts, and all the kind of quantitative data which you get hold of, and it seemed to... and the one planet living and stuff like that, it all seemed to suggest a kind of reduction by about eighty or ninety percent on the kind of Western European resource footprint I guess. And I guess, look, not just energy, but across lots of resources. And we made a guess... we did quite a nice visualisation of interdependence of different resources, so because lots of things solved one resource problem by creating another resource problem – like desalination solves the water problem by turning it into an energy problem, or biodiesel turns an energy problem into a land area problem and a food problem.
So it seemed like there’s no point in looking at one resource on its own; you have to kind of start with a kind of whole resource perspective.

And also, lots of things that are kind of incremental improvement on things aren’t actually that useful if you’re going... if you’re trying to get to eighty or ninety percent, you need like radical changes I guess. So that was... that was kind of... what we were looking for was to do something where you could do it tomorrow, but it was compatible with a kind of a future where, you know, we were talking about eighty or ninety percent reductions.

And the trip to India was basically, you know, let’s try and find the people that are living on this resource budget that we think is where we need to be, and see how they’re living, and see if there are things that we can, you know, things that we could use or turn into designs that would be useful in the developed world. And to tell you the truth, I mean we didn’t really find anything that was, you know, kind of massively transferrable. But we did kind of... we did have that realisation that actually like buying stuff and consuming was just as important, if not more important, to people living on much more marginal... in much more marginal circumstances than people living more comfortably – which I suppose you’d expect, but not necessarily.

But in the number of ways that... but that, I guess, what was interesting was interesting was how, in India, they were... people were being provided with their kind of consumerist fix with far fewer resources than we were, because they weren’t buying durable products, I guess. They were buying much more ephemeral articles.

RM - And what sort of thing? Have you got any examples of the sort of thing they got?

RA - I guess it’s like lots of, you know, kind of brightly coloured paper things and, you know, things made of flowers and sweets, and kind of... it’s almost overwhelming actually the kind of... the amount of sort of stuff that there is; but then you realise that actually, you know, it’s... there’s not much to it.

RM - Yeah, the embodied energy’s quite low.

DesWm - Exactly. Yeah. Which obviously is as you’d expect, because people haven’t got a lot of resources at their command.

RM - Are you... are you ok if I ask you just generally... a bit more generally about sort of design process?

DesWm - Yeah, definitely. I don’t know if any of this would be relevant to what you’re doing; obviously before I came to the RCA I worked for a couple of years in a small street furniture company, and I tried, when I was there I tried to... I guess I started that... their kind of sustainability and environmental policy going, and tried to do some... well I attempted to do some sustainable products, and also went through some of the sustainable procurement processes in there that was then beginning in the public sector.
So yeah, I’ve kind of... I don’t know, I might have done some things that are relevant to what you’re... I mean in terms of... I... yeah, anyway, it might be... your questions might be... I might be someone that’s suitable to answer them.

**RM** - When you were doing the street furniture, where did the briefs come from, or how were they sort of put together and, you know, what was the context that led you to be thinking sustainably?

**DesWm** - I guess I was... I’ve been interested in it for a long time, I guess; I guess most of my generation are, I suppose, or I don’t know. Like I’ve always been interested in science and reading The New Scientist and things, and so throughout the nineties, I guess, I was kind of, you know, under the impression that this was a serious issue that needed resolution and wasn’t getting the attention it merited. And then the training as an engineer and a designer, you, yeah, I assumed, like everyone else, that you realise that actually you can have quite a big effect; so you kind of... you need to be thinking about it.

And then it was quite a good time to be... to train, talking to people about it then, because that was the point at which... yeah, the... it was Porritt, wasn’t it, that created the... New Labour got him to do a... how the public sector could procure more sustainably and how public sector procurement could drive sustainable development, which I actually think the whole thing was a bit... well, pretty flawed; but... but anyway those kind of sustainable procurement codes were coming into local authorities, and like that, at that time; so yeah, it was possible to persuade the people that owned the company to do some stuff, I guess.

And also things like recycled plastic bench slats were becoming available, and... but I guess it was more of a pull than a push from... in terms of... apart from the recycled plastic bench slats there wasn’t really any other technologies that were kind of coming in to it; but then it did make us reassess some of the processes we were already using.

**RM** - Because of this green procurement thing, obviously the effect to the clients to be... we’re demanding that it be included in the designs. Was that the only kind of... is that the kind of the only time that you’ve had that kind of in a brief? Or that kind of pull from people actually asking for it? Or is it always... otherwise is it usually coming from you?

**DesWm** - Yeah. Yeah. I guess that’s probably correct. Yeah. Although unless I suppose you could call the... if the tutors... like the tutors at the RCA were kind of pushing it, especially in my second year; so in a way they were, but yeah, no, not really. Basically yeah, that was the only example there; like certainly in Dyson it’s not really... it’s not anything... we don’t do... make any design decisions differently, although they do have a sustainability policy and they have a sustainability engineer, and... but... and... but I guess their argument is what sort of things they’re doing anyway, like, you know,
basically trying to make the appliances more efficient, because the vast majority of their impact was in the electricity they use rather than in the resources required to make them. But that’s something they’re maybe trying to do anyway, because… and yeah, I guess it was because of the… because of the sustainable procurement; but I don’t… I don’t believe we were actually making more sustainable products. I have to say that.

And I think that the whole process is really flawed, because… because it’s totally qualitative, and it’s… those sustainable procurement codes are box-ticking exercises. So if you jump through the hoops you… you know, you get certified, and you don’t… you might… you, you know, you might not be making a more sustainable product; and actually you don’t even know if you’re making a more sustainable product.

So personally I don’t think… I don’t think that… well there’s nowhere near enough data available, I don’t think, to really make like something really simple like a bench, you know, a bench has got like two… two ingredients basically; it’s got slats and it’s got a framework, and they’re usually different materials, yeah, they’re some other things but let’s just talk about the slats and the framework.

So your slats, you know, you’ve got choices, you could have… you could have recycled plastic, but then by the time we were doing it there wasn’t any were making recycled plastic slats in the UK, so you could get them from Belgium, I guess, or Holland, or China. And actually if you wanted to use UK post-consumer waste you were most likely to get that in the ones from China rather than in the ones from Belgium or Holland, but then they hadn’t travelled as far. But then the ones from China maybe lasted longer, or had better mechanical performance; then also your alternative, maybe you could use… you could use FSC slats of a hardwood that would last a long time, but then it was from a rainforest somewhere very far away; or you could use, you know, you could use FSC sourced European oak or something, but then that was very, very expensive, and maybe… you know, and I assume that was because oak is less efficient to produce than Tatajuba is from, wherever, Indonesia (Brazil); and so, you know, how do you factor in the impact of the transport in comparison to the… creating the woods in the first place.

And then the standards you could do it in steel, or stainless steel, but then you’ve got making that, and the processing, and then you could do cast iron which has a very high embodied energy all cast iron has a very high recycling… recycle content because of the scrap trade, but then it’s not marketed as recycled because the scrap trade’s, you know, much, much older than people have been bothered about being green. But then if you buy some cast iron, the chances are it’s going to have like ninety-five percent recycle content or something; so it’s like that’s, you know, if you’re trying to tick your recycling box, that’s quite desirable; and actually I think
cast iron is quite a good material from a sustainability point of view, but I can’t really prove it – especially if the cast iron has come from China.

So it’s like... and then, you know, even once you’ve made the product, or when you’re moving these things around, the transport’s such a big deal; so it’s like how many slats can you fit on a pallet; well if you don’t know that, then it’s quite hard to work out the transport issue. And then well did they go by boat, or train, or lorry, and, you know, how far was the sawmill from wherever, and with the... you know, cast iron, how much scrap did they use the day that they made it, because the scrap content probably changes day to day depending on what’s around, and, you know, how big a batch did they melt that day because that will affect the...

And actually all of that stuff’s important, and just by basing things on average values, that doesn’t incentivise people to improve anything because it’s like actually you want those guys to be, you know, when they’re smelting the cast iron, to be doing it as efficiently as possible all the time.

So that was kind of... after going through all this process, that was my... that was how I felt at the end of it, but this was ultimately not helping anyone except giving people more work to do; and creating jobs for people, I guess, to say this is green.

RM - So its sounds like in... to do it properly, the level of complexity’s really high, so it’s having the information and the time to do that; versus being able to basically have enough to justify to have some boxes ticked. And it sounds like you were frustrated that you wanted to do it sort of properly so you could kind of prove that it was more sustainable, but you didn’t need to; but also it was hard for you to do at the same time?

DesWm - Yeah, yeah. I didn’t feel that I could do it; and also, yeah, there wasn’t any point in doing it, because actually if you tick the boxes then you were there. But I just... I guess as an engineer I felt very dissatisfied with the whole process. And ultimately, I guess, the kind of conclusion I came to was that where... to make it work properly you need a whole double accounting system for energy and resources, or especially energy; and well... well actually... or if you’re just talking about climate change you need a double accounting system for, you know, carbon dioxide ultimately. And if you’re... that would be very expensive and difficult to implement, and you’d just be much better off taxing it at source and then you wouldn’t have to worry about having any parallel system, and everyone would just get on with what they were doing before.

RM - Ok. Yeah. So that rather than trying to work backwards to see what the impact is of say plastics, is if you just tax the oil as it comes out of the ground then you don’t have to worry about it; it just makes things more expensive.
DesWm - Exactly. Because I think, you know, the number of... the supply chain involved in producing anything is so complicated that it would be a monumental amount of effort to do that, working backwards, and it wouldn’t be any better than taxing it at the source and having the same effect ultimately.

RM - Is there like a product out there that you are aware of that you think is a good sustainable product, or suspect might be? Obviously you might need to... most of them there’s not enough material information to be sure.

DesWm - Well I guess, hang on, I’m just trying to... my... I’ve got some... I’m just... what... I’m just trying to find a... I did a presentation actually almost exactly a year ago; I guess just about sustainable design. Or green design. I should send it to you, although it doesn’t have any... I think I’ve just got the pictures, so I’d have to type out what I would have said; but just looking through... because I had some real... ok, so first... first question, is this... if you’re creating a product and you reckon this is going to be like a properly green product, a sustainable product, first question is, is it better than nothing. So like if you didn’t make this product, would the ultimate impact on the environment be lower. So actually for a product to clear that hurdle’s quite difficult already.

And then the second question is could we all have one; so I don’t think there’s any... you know, there are certain like things that you might do; but I guess the example that those guys... what are they called? The cradle to cradle guys, they talk about Birkenstock sandals, don’t they? There are only a certain number of Birkenstock sandals you could make, and actually the whole world couldn’t have Birkenstock sandals.

RM - When you say could everybody have... you mean in terms of afford it, or in terms of is there enough... are there enough resources for everybody to have them?

DesWm - Yeah, are there enough resources for everyone to have it? Because like we... one of the other things we did on that project was we went to stay with these hippies that were living like totally off grid in Wales, in like yurts and tepees, they’ve been living there for years and years; and it was nice, because they... it wasn’t very ideological actually, it was kind of more of an aesthetic thing, you know, because they kind of... if you’d... if they’d said we’re here because we’re saving the planet, you know, you’d have wanted to shoot them down because they mostly had like... they weren’t at all self-sufficient for food and most of them like would go to the supermarket once a week in their cars, or to the shops; but they were... they were pretty self-sufficient... well they were totally self-sufficient for energy. They had like each... they mostly had two eighty watt solar panels that were giving them like light and some appliances and stuff, but then their heat was supplied by wood from... they were basically living in a hundred acres of forest, so... and there were only like eighty of them; so they were like... they were pretty
well supplied with wood, and they were quite... quite warm, even though their houses were incredibly inefficient thermally.

The point is that they can live sustainably like that, but not everyone could because there just isn’t enough forest. So, yeah, I think the... the, you know, there’s like one kind of green design is just reducing the amount of resources that go into a product which might help, but then the more interesting one is finding the products that like act as levers on the rest of your resource use, and so that then the products causes a reduction in resource use far bigger than the resources that went into the product itself. So an example of that would be like a condensing boiler, I guess.

Well actually the condensing boiler I’d say is good because it probably saves you a lot more energy than it takes to make a condensing boiler in its life, so that’s a green product I’d say. And then I guess smart meters should have the opportunity to be pretty awesome. You hope. Although they’re... what the government’s doing with them I think isn’t; I think they’ve made... making quite a lot of mistakes, and they’re not going to be as effective as they could be. The problem is that their... the mandate has been written in an extremely unimaginative way, so they’re like mandating... I mean it’s like the details; it’s like their mandating nasty little boxes with LED screens on are going to get left in drawers, whereas, you know, they just could have written it in a much more...

I mean it’s the same with, you know, the government isn’t very good at mandating things in fast moving technology areas, right; so it’s not that much of a surprise, but, you know, imagine what, like, obviously Google are doing it, but kind of imagine what the Google, when it’s really going, what the Google kind of smart meter’s going to be like, and actually, you know, does that need to be delivered to you on a nasty little LED thing. No. So yeah, I just think it’s going to be a bit of a missed opportunity.

But almost everything that claims to be... like anything that’s kind of marketed as sustainable generally isn’t, I think. It’s usually just a token, I guess. But the problem is because most people are making their decisions based on rules of thumb it works. And we need to move to a point where we are looking at this stuff really numerically.

Yeah, the one we always talked about actually was the bamboo laptop. That, I think that’s our... like that’s our worst one; we can’t think of one that...

But, yeah, and it’s pretty scary; and that was the problem, it felt like the stuff that we were doing for street furniture actually was kind of the same, because we couldn’t work it out.

And I guess it’s disappointing that like mass culture and journalists aren’t more critical, and I guess it’s because ultimately they don’t really have the... they don’t actually... they’re not equipped really to be critical, because the understanding of science and maths is so bad amongst journalists.
RM - But also, as you said, even if you do it, it’s really complicated even for when you really do know about something; or it’s a lot of time and effort to do the calculations. So it’s hard to tell just by looking at something; you do have to kind of go away, and also you need information that might not be available to you about the product, because you don’t know where they’ve sourced the materials or whatever.

DesWm - Yeah, and ultimately you need to know it to a resolution that probably, yeah, well might never be available. And actually the thing is the progress is going to be made by those tiny little changes, you know; someone suddenly thinking oh yeah, you know what, we shouldn’t be doing this bit of this journey by... in a truck, we could do it on a train and it would only take, you know, four hours longer. And you’re never going to incentivise those kind of decisions by the way that we’re going about it now, but saying oh yeah, reduce, reuse, recycle or whatever. You know, or all other advice that people are given on how to reduce their impact on the planet.

RM - So do you have an idea of what you kind of think those barriers are, or what could be done to change it?

DesWm - As I said, personally I think that carbon tax at the point of extraction is by far the thing most likely to create serious change, because we... it will incentivise the right kind of behaviour change, and it will incentivise the right like people to invest in the right technology, and, you know, have like... like what’s impressive about the Dyson is there are like, you know, three hundred and seventy engineers in a room. And like what you can do with three hundred and seventy engineers is amazing, but those like huge chunks of guys are only going to get deployed to solve the problems, you know, create the awesome technology if there’s money to be made doing it; and yeah, I guess I just... I feel like sustainable design’s been a bit of a failure, and also a bit of a... I think I’ve got to the point where I think that carbon tax is the only thing is going to work, and I think that anyone that’s claiming anything else is making a difference is actually harming the planet because they’re just detracting from it happening. And I think we’d have had it by now if there hadn’t been all of these false alternatives.

RM - the other route would be to legislate for it, but it sounds like from your experience with the furniture that you’re not even sure that the legislation would make the right changes. Is that fair?

DesWm - No. No I don’t think it... as I said, the more these things are so complicated, the government, you know... and also it takes away opportunities for innovation. Like a big victory... probably when I was doing the street furniture, the single thing that I did which had the biggest positive impact, I think, is I got TFL to accept LED up lighters to be used on those keep left signs; so the old ones were those plastic rectangled things with yellow on them; so they were always halogen, and, you know, the... whatever the
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standard for them says its halogen, so I was like well we should be using LEDs for this because it last much longer, you know, much easier to service and much lower power consumption; but it was like a massive struggle to get them accepted, and I had to jump through all kinds of hoops and do all kinds of calculations, and it was still, you know, it was just really, really, really hard.

And it’s like the same with like bike lights; LED bike lights were banned for ages, weren’t they; they weren’t legal because they hadn’t updated the British Standard. That’s what happens when the government legislates about these kind of things.

RM - That’s a really interesting thought; I think you’re right actually, particularly as these people I’ve spoken to, they’ve always said well the... I mean ultimately the incentive with any kind of product is the cost, you know, what it costs; and so, yeah, like you said, making... basically making it a financial imperative to designers in some way is way more logical than laws and directives which, like you said, almost invariably have some kind of perverse effect when you try and implement them. I guess you could argue that it would be governments that would have to implement the taxation, and it’s just getting them to agree to do it.

DesWm - And the problem is they’d have to do it internationally; it can’t be done country by country because we have international trade, and you’d be penalising one country’s exports. It... I guess I... it looks like they’re going to have this international tax on currency transactions, there’s no reason why they couldn’t... you know, why it wouldn’t be able to work; it just there needs to be will to do it.

But it all... the other thing that’s interesting is the multinationals seem quite up for it, you know, like lots of the energy companies, surprisingly, I guess because they know ultimately they’ll make money out of it, and they’ll be in a good position to... like people like General Electric and Shell, they know they’ll be in a position to... you know, they’ve got those rooms full of hundreds of engineers.

RM - Just on a slightly different area, what sort of awareness do you have of like the eco laws and directives, like the WEEE and the EUP?

DesWm - I don’t know what the EUP is. Is that an EU thing?

RM - That’s the energy using products directive, that’s the sort of thing that covers low energy light bulbs, it’s the energy used during the lifetime.

DesWm - I know about WEEE. I... yeah, no, I didn’t know about this; well I’d heard something about the EUP in that they were talking... they’ve been talking about something like that at Dyson, because apparently there’s going to be one that’s going to cover vacuum cleaners soon, and there’s going to be a maximum wattage for vacuum cleaners, and they’re quite excited about that.
They’re pretty confident that if vacuum cleaners are limited to, whatever, 1600 watts, they can definitely make the most powerful 1600 watt vacuum cleaner you can buy. Whereas at the moment someone can always make a heavier vacuum cleaner that’s more powerful.

RM - That’s interesting that actually people are positive about that coming in, because you’ve got to think more about it and then you can implement something. Again it’s down to having lots of clever engineers and people that can think a way round it.

DesWm - It’s the same reason that General Electric and others are up for all of this.

RM - Do you mind if I just ask you about like learning; like just in general when you’re doing projects, how you learn the information you need to do a project, and then possibly having got that how you share that with other people you work with.

DesWm - Actually there’s someone you should... I just thought of... have you been in touch with someone called Christopher Pett? He runs a company called PLI Design, making furniture. He did a chair made of recycled PlayStation 2s. He’s... like he’s a good man to talk to, and very approachable. I... so I’d recommend getting in touch with him. I... when I first found out I’d got into RCA, I guess I kind of quit the street furniture job a bit early, because I thought I’d learnt what I was going to learn there; and I went and spent a summer working with Christopher; and to tell you the truth I didn’t really do anything of any use for him particularly, but I learnt quite a lot about materials from him, and borrowed a lot of interesting books; because he’s... in terms of, yeah, materials, he definitely knows a lot. So that was useful. That was one source of knowledge I guess. Beyond that I’ve always tried to stay on... like generally up-to-date with what’s going on, and generally like reading things like The New Scientist and The Economist and stuff, and I’ve found that often that knowledge has come in very useful when I’ve been doing projects; so it’s not research I’ve superficially done for that project.

RM - So you’re generally building up the knowledge and then sometimes it becomes useful.

DesWm - Yeah. Often like, say The Economist, you never really learn anything that’s useful to your project from The Economist, but you definitely learn where to look, so then it becomes much easier to find the information. You know, if you’ve read some little article about something, a lot easier to find the information than if you haven’t.

So I think generally just staying up-to-date with what’s going on proves to be very useful when doing projects. Beyond that, I don’t know, I guess I... I guess I Google; it must be... or try to speak to people, like try and identify an expert and ring them up, or email them; that’s good. People often like get back to you in a surprising amount of time... amount of the time. And

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again try and look for quantitative information; I guess that’s quite important.

**RM -** I mean do you have a way of judging the validity of the kind of the information you get? Particularly on the internet where, you know, it’s hard to know where it may have come from?

**DesWm -** Well I always... I just think would I cite this; that’s my test. So, you know, you know whether you’d get away citing something or not, generally. But I guess just in terms of making a design decision, you’re right, I might make a decision based on something flakier, but I definitely try not to. I definitely try to do a calculation based on some data that I’ve felt I could cite; but that’s often quite difficult to get hold of.

And also when you’re not in an academic institution, it’s very difficult; you know, like you don’t want to... you know, often to pay for a paper that’s going... might, or might not be useful, you know, you could spend whatever they cost, like fifty quid or something, and then you might find out that actually the figures you needed weren’t in the paper anyway; so yeah, that’s a bit of an issue.

DesT-m made some quite nice top trumps based on all different materials and their embodied energy, and embodied water, and other things like that. His focus projects were... are like really, really good from this point of view, and so, yeah, it would be good when you get to talk to him. And yeah, I mean, you have... I assume they must be online somewhere, so worth looking at.

**RM -** Is that... was that one of his, you know, one of his end of year projects?

**DesWm -** Yeah, it was. Basically he and... so their group project they did the toaster project, and then his final project was about embodied energy, embodied resources, and he ended up making these top trumps; and he made these like three... these three like desk lamps based on different energy budgets; so there was like a five mega joule test lamp which was basically just a little cast concrete kind of lump around a light bulb, with a little feature on it so you could point it in different directions. And there’s... he did a... I can’t remember what it went up... like a 20 and a 50 maybe; so one was... one was like wood and plaster, I guess, the twenty; and then the 50 was like more wood and a bit of cork, and then some like cast iron counterweight. And, you know, I guess they got more sophisticated, but then more... and then he had like the counterweights were each one mega joule of cast iron; he had like one mega joule cast into them. I mean it was really beautifully put together.

Where did I start? Oh yeah, anyway, the top trump’s probably the most useful thing; and they would have been quite a useful source of information I assume, for some back of the envelope calculations on what you were doing. But that’s all... I guess I wouldn’t know where to find it, and I
wouldn’t know where to get it from a trusted source; but then ultimately I believe the whole exercise is a bit of a con; you know no matter how good your information is.

Yeah, I suppose, and then in terms of communicating, I would, yeah, try and do calculations, and then I’d do visualisations as much as possible; and, yeah, if you can visualise your data well, you can, yeah, definitely communicate quite powerfully, I think, with people.

RM - Yeah, actually that’s one of the things I’ve been looking at just in general some of the, you know, information is beautiful, and that kind of thing, where people are really looking at how you represent data in a visual way. For a start quite often you need that, because numbers, by themselves, your brain just doesn’t deal with them, the scale of things; but also just engaging people in arguably quite dull numbers.

DesWm - Yeah, well, so maybe that’s the answer of how we get people to engage quantitatively in this. Because, you know, that’s the only way we’re going to do anything and we’re beyond green wash.

RM - I guess you could argue that part of its making people aware of the impact things have now; but also if you were trying to sell something as an eco-product, you know, how do you try to quantify what that means is really difficult; particularly as there’s no, at the moment, there’s no scale. So, something’s now they have the CO2 footprint on, but that’s not necessarily that useful because if you don’t know what that means. If you don’t know what the equivalent is, it might be, I don’t know, twenty kilograms of CO2, but is that the same as a jumbo jet, or is that the same as a light bulb?

DesWm - The only thing that really matters is how does it compare to the other crisp packet probably. And then is it... incentivise someone to buy your crisps over someone else’s crisps, because then that’s the only way that label is going to have an impact on climate change; unless you’re expecting rationing. You know, ultimately the kind of... if it is making people more likely to buy your crisps than someone else’s, then what... then there are two... you know there are only two things that could be motivating them to do that – one would be rationing, and the other would be guilt. And I don’t think you can rely on guilt, because it’s a collective action problem; and like maybe you can rely on it for crisps – maybe, probably not – but you’re certainly not going to rely on it when you’re telling people they can’t go on holiday. And basically people aren’t going to accept making sacrifices if they don’t know everyone else is going to be, and have to be; you know, it’s just never going to move beyond a small few; so you need government action on that kind of macro level or either... basically either rationing or pricing to make anything happen. I think and that’s another fallacy of sustainable design is that this guilt thing actually works.

But that’s what’s really frightening about this whole thing is that that’s the whole tactic of the environmental movement, and it has been for, you know,
since climate change came to light; well maybe not since climate change came to light, but it has been for, you know, at least certainly for the last ten years when it’s been getting any attention, it’s like, you know, make it an ethical issue and it will get sorted out; and its totally not going to work. You know, like do you remember all that stuff that came out about the... all the MPs and how they were observing the 10/10 thing? It’s just, you know, the perfect example of how this guilt thing just, whatever, ethical thing doesn’t work at all.

RM - Guilting and scaring people doesn’t seem to have worked very well at all.

DesWm - No, well I don’t know; I think scaring people could work if they were scared into consenting to the right things. The problem is, is that they’re scared, and also rendered impotent, you know, because no one’s really telling them what they can actually do.
Transcript of interview with DesX-m conducted on 17/02/2011 at ComT-m

Below is a sample of a transcript on an interview conducted as part of the Main Study. To maintain confidentiality names and places have been replaced with the codes described in Appendix F.

RM - The first thing is just really asking about ComT-m, just if you could give a brief overview of maybe how big it is, how the hierarchy works and how many designs, and how it breaks down.

DesXm - We’ve got five directors – one of those is the managing director. Then currently we’ve got around about 12 industrial designers including graphics then we have a prototyping department which is on the ground floor where you came in. So we’ve got a full workshop where we all prototyping. Basically, we’ve got CNC-ing machines, we’ve got SLA machines so we’ve got a pretty good range of prototyping techniques. Mainly the thing we do is polyurethane castings to replicate injection mouldings and that kind of thing. And that’s fairly unusual for a design company to have all of that in-house.

RM - Is there a company ethos and also is it quite a top-down company? You said you had the five directors.

DesXm - The structure of the design studio is you’ve got directors who are involved with either sales or day to day resource management or just directly involved with projects. But mainly the directors are ... actually, it’s very evenly spread. They do quite a bit of sales, quite a bit of management. It’s a fairly level playing field. We have senior designers like myself who run projects and then the more junior designers who do more of the project work. But I wouldn’t say there’s much hierarchy structure there, it’s pretty much director, senior designer, designer level and then in the workshop again it’s very level. We’ve got one of the directors is the workshop director or prototyping director and then the workshop numbers tend to go up and down a little bit more just because depending on how busy we are we get freelancers in. I think it’s about 10 full-time staff from what I remember. But it’s not really any great hierarchy, I wouldn’t say.

RM - The next bit really is just about the designer process but in particular initially how briefs come in, how they’re set, whether the clients very much define it themselves or whether it’s more of a discussion when the briefs are initially set.

DesXm - The way most projects work is we’d get contacted by somebody who says, “We’re interested in you doing this,” so probably one of the directors or one of the sales guys would go out and see them and have an initial meeting; get a basic understanding of what their requirements are; a basic brief and we’d come back and we’d write a proposal which kind of outlines what they’ve asked us to do. That’s an official proposal that we have a set format
for and we would put in that the design brief and then what we’re going to do and then how much it’s going to cost. Sometimes that’s very defined if they give us a really good brief up front. Sometimes it really varies. You get one extreme to the other. Some people have a very, very defined brief of exactly what they want you to do yet other people haven’t the faintest idea and you need to go through a few drafts of that initial proposal to get to something where everyone’s agreed on what you’re going to do. Once you get to that point they agree a price and then you make a start from there.

**RM -** Once that’s got going who’s actually involved in the process of making it happen?

**DesXm -** You’d have probably director level with the initial sales side. Once you’ve got the proposal and you’ve got kick off and meeting then they pretty much step back and then you’d have a senior designer come in to manage the project and depending on how big it is they may do up their own or it may be that you need two or three people on it. But say it was a reasonable sized project that needed a few people on it you’d have one senior designer then two or three others who would all be working through that senior designer. It does vary massively. Sometimes it’s a single person, other times you could have up to three or four people working on it if it’s a very tight deadline, for instance.

**RM -** You’d have an expert external people involved if there’s a specific ...

**DesXm -** Yeah. We’re industrial designers but quite often projects we do require electronics or if it’s an engineering project you might need to get some computer simulation FEA or CFD work done so, in that case, we would have external partners that we use. The main one is electronics – we don’t to electronics so we need an external partner and they’d be brought in just when they’re needed, usually right at the beginning. It totally depends on the project, really. Obviously, we try to do as much in-house as we can but there’s certain things we definitely can’t.

**RM -** The next series really about learning so how you can acquire information and what sort of resources would you use and then is there any way of sharing the knowledge between the designers?

**DesXm -** Specifically what we’ve been manufacturing.

**RM -** Yeah, anything really. It might be trying to find out about in a new material or a new technology or whatever, really.

**DesXm -** That’s an interesting question, really, because I’d say we probably don’t have a structure in place for finding out about all the latest technologies. We rely on publications and people reading up about stuff or there’s a lot of very good websites now where people browsing through those. They’ll send out a link to everyone, “Check this out, this is good.” And actually, that happens a lot now where people see something cool and they send a
link out to. We obviously keep our own records of all the different suppliers that we use and specialists in one area or another and that’s built up over quite a period of time, really.

RM - Just in general, do you have any way of deciding the reliability particularly, say on the internet, whether you consider what you’re reading is necessarily true?

DesXm - I think if you read stuff on the internet it tends to be, more often than not, it’s something that’s out there. “This is cool, this is a new thing that somebody’s doing,” but it’s very rarely that it’s something that we can definitely use that with this project. It tends to be, it’s somebody who’s doing something inspirational; they’ve developed a new plastic which they can grow on trees or something. It’s probably unlikely that it’s at a stage where we can use it. What we do have quite regularly is we have salesmen in from the big major plastic companies. They’re very keen to come in and talk to us so we do need to rely on that for specific information. They’re more than happy to do that. That’s much more realistic cos these are guys who can sell you something right now. In my experience they don’t tend to be – certainly on the sustainability side – they don’t seem to be that interested in it but it’s not something we’ve actively gone out and asked them particularly.

RM - Have you come across any kind of eco tools, eco websites or that kind of thing?

DesXm - Yeah, there’s a lot. There is stuff starting to happen and that’s definitely one of the things that probably more often than not if the people find something cool on a website quite often it’s environmentally friendly plastic or something that somebody has seen. Again they tend to be, “This is cool, it’s in development.” Actually finding specific materials which you can guarantee, “That’s going to make an impact.” It’s much more tricky and also manufacturers can make wild claims about things. The trouble is more often than not we are trying to develop something where we need it to do a specific task; it needs to be a particular plastic because we know that that works and although you might like to try something else that’s a big liability for us because if we’re saying, “You should use this,” then we need to prove to them that it’s definitely the right thing for the job because they’re investing a lot of time, investing a lot of money in developing their product and it’s got to be in the right material. So it’s more often that you wouldn’t even get that opportunity. Having said that, that’s because we haven’t really pushed it so if there was more emphasis on us pushing that thought process then who knows? It might be a different story.

RM - The brief point where you’re discussing what the products – I guess some products they’ve just said, “We want X.” But I guess there are other ones where there’s potential for if you have the expertise or the will that you could actually suggest sustainability?
DesXm - Just to give you a bit of background specifically on the sustainability, it’s something that we’ve identified that as a leading design company we should be doing a lot more. And there’s a core few people within the company who are very keen to promote it, however, it’s not seen yet as something that we can specifically identify or we can sell to people. I believe that it is but it’s not something we’ve done before and therefore it’s a tricky thing. You’re trying to sell your design services, you’re trying to sell this and that and then on top of that you’ve got to say, “Oh, and we can also look at life cycle analysis of your product. It’s going to cost you this much extra.” Now, for us that makes great business sense because we’re getting more business out of the client but there is a risk that they just, “We’re only asking you to design the thing. We don’t care about that.” So it’s been identified as a potential kind of new source of business for us. Life cycle analysis is something that we’ve been looking into and it’s clearly more important to designers at design level than any other level within the manufacturing process because you’re designing something and you understand the whole life cycle analysis of the product. It’s much more important that you do that right at the beginning and analyse it right then than much later on. But it’s still very much in its infancy. We don’t have the resource in house to be able to confidently say to clients, “We can definitely tell you the life cycle analysis of this cup is going to be this.” There are people who are starting to do – specialist consultancies and universities – they can do that. And it is definitely a growing area but it’s hugely complicated. If you were to do the life cycle analysis of your tape recorder you’re looking at a huge bill of materials within that. Every single one of those has a different impact and then its impact on energy use, water use, natural resources. There’s so many different things that you can judge it on and it’s becoming identified but we need to start looking at this. But it’s a very difficult thing to sell right now because unless the client is specifically interested in it which generally they’re not, it’s quite difficult for us to say, “You should definitely do this.” And also we can’t confidently say that we can do it either because it is a hugely complicated process to do but that’s not to say we couldn’t do it because there are more and more websites around and consultancies around where you can. Quite often it’s a formula – you put a plastic in and it tells you, yeah, this is what it would be. It’s becoming much easier and some of the CAD software now includes life cycle analysis. SolidWorks has a plugin, and there’s other websites and things so it’s coming in but until it’s more established it’s very difficult to make choices on materials because you need to have that knowledge, really. So the moment when we’re making a choice about something we make a choice on what’s cheapest and what’s best for the design but the sustainability factor is pretty much zero in the choice at the moment. Well, that’s not totally true. We try to but it’s not something customers are asking for.
RM - It sounds like it’s a mixture, there’s no pull from the customer but although people who are interested in it and can see that it could be a growing area there’s also an issue of not necessarily knowing enough. There is a lack of information as well or knowledge.

DesXm - It’s a tricky subject because there’s a chicken and egg situation in that designers can turn around and say, “Well, our clients aren’t asking for it, therefore, there’s no point in us supplying it.” Equally, designers aren’t telling their clients that this is what you need to be doing and we can provide it. Therefore it’s just not happening at all and probably the main people that are doing it are a lot more of the bigger corporations are doing probably a lot more than you think. The problem is it’s quite a boring thing to do, you know, like doing a whole lot of accounting. It’s quite a complicated process, you’ve got to be quite methodical the way you go through everything. You miss one thing out and it could make a massive difference to what results you get at the end. So it is a bit dull. And the other thing is what does the supplier do with it? Can they use it as a marketing campaign? “Yeah, we’ve done an LCA on this and we’ve significantly improved it from what it was.” The problem with that is that if you make those claims you’re then open to abuse, you’re open to people questioning your claims. So it’s again this chicken and egg situation where you’ve got people who are saying ... a lot of big corporations are actually doing a lot more than you think. What always amazes me is they don’t talk about it but if Tesco’s is doing a whole load of sustainability things then they know that if they say too much then they’ll get bad criticism in the press because, “Look, Tesco are making this claim and yet they’re still doing this.” And actually it backfires on you and I think that’s another big risk about the whole thing at the moment is that people are scared about making claims because of the greenwash issue.

RM - Also potentially the other 99% of their products that haven’t used EcoDesign, if this is so much better, why are you still producing all these other products you haven’t improved.

DesXm - If you are making those claims it is debatable what it’s doing for you and the whole greenwash side of things is people become cynical about therefore you could make the claim and actually people say, “Well, I don’t particularly believe you anyway.” What it almost needs is to get to a point where everything has got to have a life cycle analysis and it’s got some kind of rating because at the moment it’s some have and some haven’t and some are making claims which are clearly false but they can get round it by saying, “Oh, yeah, we’re not doing this but ...” a bit like BMW making a claim that one of their cars significantly reduced the CO2 output from it. But when you look at the level compared to a much smaller car it’s significantly higher and so they’ve made the claim but in reality, it’s meaningless. So it’s a really murky area where people, I don’t think at the moment, can see the benefits
of it unless there’s a cost benefit. Unless you can say, “Well, actually, ...” or they just happen to be that way minded and they seriously want to improve. I think there’s a carpet manufacturer who I forget their name, they lead the way – a huge carpet manufacturer – incredibly pollution. They pioneered carpet types so that instead of having to replace an entire room you could replace ... but also they went through their entire manufacturing process and they saw how much pollution they were making and they went through it and totally now have a zero carbon emission. They’re held up as one of the key examples of one of the ways that you can totally transform your business. I think if you look at the figures they probably saved themselves a whole lot of money as well. It’s happening but it’s tricky for us as a design company to see a major benefit. It’s something we’ve got to do and everyone knows we’ve got to do it and then we all know that we shouldn’t use a car and we still use a car. It’s difficult to see at the moment how it’s going to really progress.

RM - One suggestion I’ve come across is that if you want to get a critical mass of successful, sustainable products – basically like a standard bearer – people will pile in because they see it’s actually working but at the moment there aren’t enough. But it’s almost like the whole thing needs to be kick started, somebody’s got to lead the way.

DesXm - There are things like the Toyota Prius which is a hybrid car. I think Leonardo DiCaprio started driving it and suddenly everyone was driving one. So the issue is that if you do LCA analysis it strips it down to really actually this is good or bad. And there’s an awful lot of things that make claims and you make it out of a bit of recycled cardboard. There was a perfect example I heard the other day of using popcorn as a packaging material as opposed to polystyrene. Now, if you asked anybody what would be a better material – popcorn or polystyrene to put in the packaging to protect your products – everyone would go, “Popcorn is brilliant, isn’t it?” Green, now, when you do the life cycle analysis it comes out that actually polystyrene is far better if you look at it from certain things such as water, your energy resources. So it is so difficult for consumers to understand what they perceive is popcorn is brilliant. To then explain to someone, “No, it’s not. Actually, polystyrene, as we all know, is terrible is actually better.” It’s a very confusing thing to get across to somebody so you’re right, it does need some kind of key products out there. Like an iPhone which has an LCA that proves that is the best design of phone but it’s a difficult thing for a consumer to understand and so many people make so many false claims and that makes it even more confusing. So it almost needs a rating system, an official body to ... they would judge it as to, “We’ve done our analysis and we agree with their claim.” Or, “Actually, we’ve done our analysis and what they’re claiming is totally false.” At the moment there’s no one doing that. All you get is if some manufacturer makes a specific claim there are
regulatory bodies which will take them to court if they think actually, the advertising is false. It comes around the advertising regulations rather than specific claims about the LCA. So it’s a bit different but that is happening and I think it’s happening more.

RM - As I was coming down on the radio they were talking about a carbon trust and their carbon footprints and I think it was Tesco’s and they’ve now got loads and loads of products with the little footprint and the amount of grams of carbon.

DesXm - Obviously is Tesco’s do it then it’s much better. The other thing I’m aware of is this idea that using your mobile phone is you take a barcode off a product and you get immediate information on your phone about the whole LCA of that product. So you can go into an electronic store, if you want to compare two laptops you either can take the barcode or you can key it in and it’s something that I know is happening. I don’t know who’s doing it and I don’t know how far it’s got but that is fantastic. It needs that kind of level of a structure in place, I suppose, to get it going. That’s available to everyone and suddenly the decisions that you’re trying to make – it’s popcorn or polystyrene – if there’s something that can tell you immediately actually these are the figures, you want to go for polystyrene. It makes it easy and there’s not that confusion anymore. There are people working on those kind of systems. I don’t know much about it but I have read about it and heard about it and I’m guessing it’s probably a university somewhere. The database and then you get into difficulties about manufacturers who might sue you if they think you’ve put a wrong bit of information there. It would be a huge undertaking to get something like that off the ground and that would be consumer driven because if a consumer’s not buying your product because you’re not on the database you’re going to make sure that you get on there. So I see unfortunately it’s consumers who are going to drive it because governments do absolute f-all. You can just see from Copenhagen – just not interested at all. Nothing is going to happen through government regulation, it’s going to have to be consumer and big corporations like Tesco’s. They’re the ones that are going to make the difference. You’re not going to get anything through government regulation and they’ll never agree on the system anyway. America will always go and do their own thing.

RM - Just on that, what do you know about WEEE and EUP and the various eco European directives?

DesXm - The first one that came in was ROHS one which was specifically for electronics and that’s regulated and as far as I’m aware people adhered to that. It’s pretty well enforced, it doesn’t affect particularly what we do because we don’t really do any electronics or if we do it’s external. WEEE is an interesting one because it’s not enforced. I’ve done a bit of research on it because I saw it as a way that we could maybe try and get our clients
a bit more interested in the process saying, “Actually, there is something at the end which says you are liable for the disposal of your product.” It’s a bit of a murky area within medical industry. There are certain medical products which are exempt basically if it’s any form of contamination then a medical supplier can say, “We’re not covered by WEEE.” Military aren’t covered. I think the only place where it does seem to be working is in bigger appliances like fridges, freezers and washing machines where the end thing is a big old lump and they can to a certain extent be broken down and recycled. There’s a few companies just in Bristol who do that. They’ve sprung up purely because of the WEEE regulations and they recycle washing machines and I’ve asked them, “Do you ever do anything smaller like laptops or anything like that?” And they said basically they can’t get them in big enough supplies to make it work and also you’ve got to be quite specialist in one particular one. So, in general, I don’t think WEEE is doing very much in the smaller consumer market. If my DVD breaks down, in theory, I can send it back to Sony or someone. The average consumer, even if they’ve heard of WEEE which is probably only 10-20% of people, still wouldn’t know, “How the hell do I do that? Who do I send it to?” If you did manage to get through to Sony they would tell you, “We’ve got this, send it to so-and-so and you may be able to send it to them.” It’s a lot of effort for you as the consumer. You’ve got to be pretty committed to it. Sony aren’t falling over backwards to do it for you, or any of them, not just them. In my opinion, it’s only working within bigger appliances and it’s not enforced particularly, I don’t think. I the work we do it has never, ever come into a single project we’ve done. I would guess that’s probably the same for most of the design companies out there. I saw it as an opportunity. I thought we could go to manufacturers and say, “Look, you probably haven’t heard of WEEE but it does put the emphasis on you to dispose of the product afterwards.” It’s a huge investment for the company and responsibility and most of them aren’t the least bit interested – once it’s gone out the door they don’t want to see it again. So it’s a very difficult thing to sell and unless lots of other people are doing it then they’ll go and do it. We’ve been involved in a project or a company up in Scotland through Genesis who they’re involved in basic take back programmes where you’ve got two main ways that that happens. If you buy a laptop and then it’s either faulty or you return it, it goes into the slightly grey market where it can be repaired or it might be anything wrong with it anyway. It might be somebody couldn’t work out how to use Windows so they just took it back. But it’s no longer a new product and it’s difficult to see whose responsibility it covers. You do see more and more, like, laptops you can buy as – what do they call them – I can’t remember the exact name but basically the product’s been sold but it’s not remanufactured. It’s something else. I can’t remember the exact phrase but this company is involved in doing that. People don’t really want
to buy them because they’ll, “I don’t want to buy that.” Even though they might be significantly cheaper there’s still this perception that there’s something wrong with it. So that’s one thing where there is a take-back programme. That’s enforced because manufacturers have to do that. This company also do work with Virgin Media with set-top boxes. They take those back, test them, check that they’re alright and then they can go to another customer. So there’s actually this process where set-top boxes have a huge turnaround. They go round and round and round, they’re not thrown away, they reuse them and it’s something we looked at. An internal project we did. There’s this totally different way of owning a product, really, where electronics which you almost hire it from the company. Like, Virgin would come and say, “Okay, if you want a media system we can hire it for two years. We’ll take on all the responsibility for it. If it goes wrong just send it back.” And they have a system in place where there’s a factory like we went to which they test everything, they can fix it – usually, it’s very easy to fix and it goes back out into the market again. We did a bit of work on a mobile phone which used that system and the trouble is it’s a huge – again it comes down the consumer getting their head around not owning something. Stuff’s so cheap that they think, well, I may as well just buy it. If it goes wrong I just chuck it. Actually, that’s not sustainable at all and it’s very easy to quite often if something goes wrong to fix it. There’s no system in place to do it. It’s very easy to design electronics so you have a port that you plug into and it does a self-diagnosis of exactly what’s wrong with it. Nobody ever designs that in because all they’re worried about is getting the cheapest boards that they can possibly make and getting them out the door. There’s so many opportunities of different ways that we could make electronics more sustainable but so much of it is the problem at the moment is there’s very cheap stuff out there. If it goes wrong you just buy another one. So again it’s a completely consumer driven process and it’s up to designers, I think, to sell the idea and say, “Look, you could do this,” but it’s tricky because we’re competing for the business. We’re trying to get a design business let alone get them to totally change their mindset. These things are happening, I think it takes someone like Virgin Media who said, “Look, we’ll supply you all your electronics – your TV, your stereo, your box,” and it would gradually come in that way.

RM - You sell its service and it makes sense for electronics because they do become obsolete quickly.

DesXm - The TV industry at the moment is horrendous because people are buying TVs then they find out they’re a bit crap or another one’s come out and they’re big products which generally aren’t being recycled as far as I’m aware. I’d say probably the TV industry is the worst example at the moment because there’s just so many. If you go to buy a TV now there’s so much
choice and they’re changing all the time. There’s no sustainability considered in there at all.

RM - You were saying about the consumers – I was talking to someone who’d actually been over to India and the original idea was maybe we can learn how India does things and apply that over here. But the one thing he found was that actually the human desire to consume stuff was exactly the same over there it’s just that they consume consumed much, much cheaper things. A lot of it was paper based and basically just stuff. Just different kinds of stuff and I think they were quite shocked that, yeah, actually it doesn’t matter. It’s not just a western thing, it seems to be a human thing.

DesXm - No, and I think China’s a perfect example because in China people are starting to have more money they can consume more and it’s a basic human craving to consume. You’re always looking for the better bike or this or a better car. You’re earning money and you want to spend it on something. That’s not ever going to change and I think the key for designers is to understand that but work out ways that you can get round it from a sustainability point of view. It’s pointless when you hear people saying, “Oh, we’re consuming too much, it’s terrible.” You’re just burying your head in the sand and I think there’s an awful lot of that that goes on in the environmental world where people campaign, “Stop doing this, stop doing that.” But it’s naïve because people aren’t going to stop. What you need to do point them in a better direction and that is the key to us as designers to understand that and make sure that you can put them in a slightly better direction which is more sustainable. The simple thing is if we design a new mobile every year, if we said to someone, “You should only buy one mobile phone and make it last for 10 years,” we’ve just lost a lot of business. So has Nokia or whatever because they’re not selling mobile phones anymore. They need to have a revenue input from something else and it may be that you sell them apps. They make all their money from apps. But everyone needs a revenue, everyone needs revenue coming in so it’s a tricky one because you can’t make people stop buying. Never going to happen but you can make people buy more responsibly with more understanding or make them buy things which just don’t have an impact. iPhone is a great example because, in theory, the iPhone is a basic thing now, it’s just a screen. If you make that to last you could make all your money from selling apps for it because “I wanted that one because my mate’s got it and it looks a bit different. It’s a bit uncool cos I’ve had this one for nearly six months now.” It was driven by that whereas the good thing about the smartphones is that suddenly it’s only a screen. It might be last year’s model but it’s not so bad and as I say, we did an internal project in ComT-m looking at a mobile phone and how you could change peoples’ attitude and we did a whole load of work on the whole user interface and you bought upgrades for your phone or you bought new apps or something. People could still
buy which is what they want to do and want to make some money but what
you’re not doing is buying a new mobile phone every six months. And that
was just one example. It’s obviously great for Smartphones because you
can sell something else but it’s a tricky one and I think when costs are so
low people can easily carry on buying. If you buy a really expensive watch
you don’t want to go and buy one every year and that’s the problem with
China churning stuff out so cheaply. You can go and buy your Tag Heuer
or whatever for hundreds of thousands whatever but equally you can go
and buy a new watch for 20 quid and buy one every year and one is more
much more sustainable than the other but there’s that human desire to
consume is difficult to stop but I think it’s down to us to ...

RM - That’s been really helpful, thank you. Is there anything else you can think of
or anything you wanted to ask?

DesXm - Have you talked to IDEO?

RM - I haven’t but mainly cos they’re too big. At least within the remit of what I’m
doing.

DesXm - It would be worth trying to because I know they are doing probably more
than anyone else. Again, I don’t think they’re selling it particularly but I
think just within the culture of their company it’s something that they’re
looking at. I don’t know much they’re doing directly but I think on their
website you’ll find a bit of stuff. I know they’ve been working – do you have
“Forum for the Future”?

They’ve done work through them so you might find they’re quite helpful
actually. I know they’re big and it’s probably difficult to get through to
anyone but ...

They are internationally known and when they’re doing something then
everyone else starts doing something. So I’d definitely recommend trying
to get in there if you could because I suspect you’d get quite a good
response from them as long as you get to talk to the right person.

My vision is that KD lead, certainly in the UK and I think personally there’s
a lot of work out there for us. I think it’s a huge opportunity. Generally, the
problem is that when you approach businesses with not something that the
marketing department deal with most big corporations have a sustainability
sector of some sort. They all have to write their annual reports and they all
have to have a sustainable section. Sometimes it’s very good, sometimes
it’s probably there because it has to be. But the difficult thing is within big
companies getting into that cos the normal routine with any company is
through marketing or R&D or something whereas you’re almost getting in
from a slightly different direction where you need to be dealing with that
department. So I think that’s the tricky thing is it’s not probably the front
facing aspect of a company particularly, either.
RM - So is it often the marketing actually drive the briefs as opposed to designers/R&D?

DesXm - It depends. It’s usually a bit of both, marketing have their requirements, the R&D have their particular requirements and it’ll be a mixture of both of those. It varies, sometimes marketing people aren’t involved at all. If it’s a small company there might be one guy who does both. But generally, the part of the client that we deal with is a marketing department and, for instance, R&D department. So you’d have somebody from both of those that we’d deal with and quite often marketing will have something they want that’s out of scope with what everyone else wants.

RM - A few people have said that the other thing with marketing is quite often they’re basically asking because the competitors have done something so they want the thing a bit like what the competitor’s done.

DesXm - Yeah, “So-and-so they’ve got a green product,” and at the moment Apple dominate everything. It’s like so often you hear somebody saying, “I want it to look like an Apple.” It’s like, “Okay, we’ve heard that before.” And you’re right, the problem is that as a designer you’ve got the vision to say, “No, you don’t want to do that. You’ve got to do this.” But at the same time, we’re not generally in that position, we’re not strong enough to be able to say, “You shouldn’t do that, you should do this because it’s a big risk for us.” If their sales fall off then they’ll blame us. And it’s a big risk for them because if the sales figures fall off they’ll say, “Well, why the hell did you let that design company go off and do that? You should’ve stuck with what we know.” So marketing more often are following rather than leading. Before here I worked with Mark Newson and he was a totally different company to work for where people come to him because they want his designs. They don’t say, “Mark, we want you to design something to look like this.” They employ him because they want something new and imaginative and is a Mark Newson. But that’s very unusual. Most companies don’t get that power. But again it’s down to us to try and persuade them, “Actually, we think you should do this,” and it’s this chicken and egg. We have to be careful we don’t piss the client off by doing something totally that they don’t want. At the same time us as the visionary side of the business we should be trying to point them either whether it’s the look of the product or whether it’s the sustainability. We’re the ones that should be trying to push them in that direction because generally, they don’t probably think about it themselves. Their only thing is, “I’ve got so many products to sell. To keep the figures up.” Otherwise, they’re out of a job.
Appendix L: Main Study Analysis Codes

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Appendices

Briefing Process\Hierarchical or Personality Driven
Briefing Process\Human Appeal
Briefing Process\Pitch
Briefing Process\Reassurance
Briefing Process\Research
Briefing Process\Resistance to Change
Briefing Process\Sliding Specification
Briefing Process\Specification
Briefing Process\Visualisation
Company Ethos
Company Ethos\Ethical
Company Ethos\Localisation (Good or Bad)
Company Ethos\Real Solutions
Company Ethos\Survival and Growth
Company Ethos\Sustainability
Company Ethos\Usability
Design Process
Design Process\Balance
Design Process\Break Up Problem
Design Process\Collaborative
Design Process\Combine Function
Design Process\Concepts
Design Process\Design Led
Design Process\Editing
Design Process\Expand & Contract
Design Process\Feedback to Client
Design Process\Holistic Approach
Design Process\Manufacturers Modify Design
Design Process\Minimise Innovation
Design Process\Minimise Parts
Design Process\Multi-Skilled Designers
Design Process\Patent Search
Design Process\Pricing Point
Design Process\Problem Solving
Design Process\Project Dependent
Design Process\Sub-Contractors
Design Process\Systematic
EcoDesign
EcoDesign\Appropriate Technology
EcoDesign\Bad Terminology
EcoDesign\Choice Editing
EcoDesign\Competing Eco Strategies
EcoDesign\Complexity Issues
EcoDesign\Consumer or User Behaviour
EcoDesign\Consumer Understanding
EcoDesign\Consumerism Conflict
EcoDesign\Design Durability - Upgradability
EcoDesign\Design for Disassembly - Waste Separation
EcoDesign\Efficient Distribution
EcoDesign\End of Life
EcoDesign\Energy During Use
EcoDesign\Export CO2
EcoDesign\Fluid Specification
EcoDesign\Good Design
EcoDesign\Government Policy
EcoDesign\Green Washing
EcoDesign\Innovation
EcoDesign\LCA & Benchmarking
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EcoDesign\Motivation\Eco Acceptance
EcoDesign\Motivation\Ethical Interest (Morals)
EcoDesign\Motivation\Family Influence
EcoDesign\Motivation\Greater Awareness (Zeitgeist)
EcoDesign\Motivation\Legislation
EcoDesign\Motivation\Profit and Marketing
EcoDesign\Optimized Manufacturing
EcoDesign\Packaging
EcoDesign\Recycled Materials
EcoDesign\Re-use or Repair
EcoDesign\Risk of Criticism
EcoDesign\Sales Volumes
EcoDesign\Simplification Eco
EcoDesign\Societal Change
EcoDesign\System Change
EcoDesign\Transitional Solutions
EcoDesign\Unintended Consequences
EcoDesign\Unnecessary Products
EcoDesign\Whole Life Costing
EcoDesign\Whole Lifecycle
Information Matters
Information Matters\(No) Sharing System
Information Matters\(Un)engaging
Information Matters\(Un)intuitive
Information Matters\(Un)patronising
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**Legislation**

| Legislation |  |
| Badly Written Rules |  |
| Battery Directive |  |
| Company Driven |  |
| Consistent Collection Criteria |  |
| Designer Freedom |  |

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Legislation
ELV
Legislation\EuP
Legislation\European Integration
Legislation\Exemptions
Legislation\Expensive to Comply
Legislation\General Awareness
Legislation\Ignorance
Legislation\Individual Schemes
Legislation\ISO 14001
Legislation\Limited Enforcement
Legislation\Limits Innovation
Legislation\Minimal Impact
Legislation\Motivation for Change
Legislation\Packaging and Packaging Waste Directive
Legislation\Pedantic Application
Legislation\Perverse Effects
Legislation\REACH
Legislation\RoHS
Legislation\Safety Rules
Legislation\Separate Department
Legislation\Sign of Quality
Legislation\Standards
Legislation\Supplier & Manufacturer Knowledge
Legislation\Too Complex
Legislation\WEEE

Solutions
Solutions\Black or White Materials List
Solutions\Business Model for Resource
Solutions\Carbon Tax
Solutions\Client Pays for Eco
Solutions\Credit System
Solutions\Designer (Product) Knowledge Share
Solutions\Diggo, RSS, Twitter, Wiki
Solutions\Eco Tool or Game
Solutions\Eco Tool Specification
Solutions\Eco vs Cost Hierarchy
Solutions\Forum
Solutions\Green Business Model
Solutions\Internal and External Usefulness
Solutions\Multiple Levels
Solutions\Payment = Accountability & Trust
Solutions\Promotion of EcoDesign
Solutions\Scalable Resource
Solutions\Simple Standard Data Entry
Solutions\Simplify Legislation (Eco Briefs)
Solutions\Trail-blazer
Appendix M: Centroid Clustering and Squared Euclidian Distance Algorithm


Clustering Matrix and many clustering methods, actually utilize two algorithms, in this case: Centroid Clustering and Squared Euclidian Distance. The first algorithm is used to determine ‘what’ to compare. As items are grouped into clusters there are several ways to compare the resulting clusters. Clustering Matrix uses centroid clustering. Meaning, as items are clustered into groups, that group is represented by a new single item, a centroid, which is the average value for all the items in the group. Distance is then computed to this new average item. At first, this is a trivial step since clusters are composed of individual items, and any item is the average of itself. As clusters are formed the algorithm for comparing clusters becomes important.

One benefit of centroid clustering is that it is a compromise between the sensitivity of complete-link clustering to outliers [in the cluster] and the tendency of single-link clustering to form long chains that do not correspond to the intuitive notion of clusters as compact, spherical objects. However, centroid clustering may not create optimal clusters at every step. This is important because it can cause some distortions in the clustering. As items form clusters, the distance between these islands should increase at every step. Centroid clustering may cause clusters to move towards each other, a violation of a basic premise of clustering algorithms. Clustering Matrix will not highlight when these inversions occur, but you should be able to visually check that every item belongs in the group. You may find non-intuitive clusters and should feel empowered to make minor changes where necessary. Generally, if something seems off, both conceptually and visibly, don’t include it in the cluster. We accept these quirks because of the conceptual simplicity of the algorithm.

The remaining question is how to measure the distance between the centroids. The first algorithm, an averaging algorithm, told us ‘what’ to compare. The second algorithm, a squared Euclidian distance algorithm, tells us ‘how’ to compare the ‘what’.
This second algorithm computes the distance between every item in the list. In Euclidean distance, the distance between two items is as the crow flies. In this case, a squared Euclidean distance algorithm is used to avoid the need for a square root. While squared Euclidean distance magnifies the difference between distances, this amplification is not a significant distortion since Clustering Matrix uses a standardized scoring system. Thus, everything will be equally amplified, relatively speaking.

Once the distance measures are computed, Clustering Matrix selects the pair with the shortest distance between them and clusters them. In the case of ties, they are merged in random order. By doing this process repeatedly the items are clustered into higher order clusters at each pass. This is called pairwise agglomerative clustering, as opposed to divisive clustering. In divisive clustering, one starts with one cluster and successively splits it into sub-clusters. In general, the further apart the items, the more dissimilar. Clustering algorithms are programmed to stop clustering either when the clusters are too far apart to be merged, distance criterion, or when there is a sufficiently small number of clusters, number criterion (Schoppe, 2010).
Appendix N: Close-up of Average Link Clustering Matrix

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Appendix P: Guiding Principles for d.eco Web Resource

Information distilled from the Main Study to guide the creation of d.eco website.

**Internet**

“Well, obviously internet has made a profound difference to the way one works.”

“I mean if we need to find something now, you’re straight on the internet and you can find an answer.”

“On a design project day to day for a kind of practical information would be internet and phoning up suppliers.”

“So most of the time I just go straight to Google and find someone new.”

“It’s changed, hasn’t it, enormously? The biggest factor is obviously the internet, it is massive.”

“I mean the predominant way of finding information is through the internet.”

“The internet is a huge vehicle for learning for us.”

“When we do our research process, we get as much knowledge as we can whilst just sitting at our desk.”

“The net’s a pretty good port of call to start with.”

“If a brief is to kind of search out for new materials, that’s kind of just done like by the internet.”

“The brochures and technical data online is, as a resource, it’s unrivalled really.”

**Communication**

“Maybe it’s about building a platform of communication and then on top of that you lay this layer of information on it.”

“So to make it usable, I think it’s the case of making it easy for people to upload the information so it’s not a dedicated team of people finding information and putting it up. It’s a collective thing. Everyone’s doing it.”

“I’m sure there are opportunities in terms of that layering of how somebody can engage with the information and yeah, that mixture of seducing them sometimes and giving them more depth in other ways.”

“If you can make it shorter, the information, rather than reading pages and pages, it’s so much easier.”
“You want snippets of information to find the stuff relevant. I suppose we always do that don’t we? We look at the title, mostly for example. Just read that and then find the one relevant to read further.”

**Visual Engagement**

“You think about first engaging people visually in what’s gonna spark their interest in something.”

“You have to use serious amounts of visual coding so you’re employing colours, textures, graphic blocks, all of those things because otherwise it won’t pull people in.”

“Most designers are dyslexic and have a short little attention span so unless it’s highly visual, highly tactile they won’t use it.”

“It’s got to be brilliantly visually accessible, completely intuitive, un-patronising and if you do an audit on any of the tools out there, they’re a complete turnoff and they’re kind of inaccessible if you think about a designer’s mind.”

“Most of the time is somebody will say, ‘Ah, that looks good. Okay, I’ll have a look at that’ and they almost assess it visually before they assess the information that’s given to them.”

“Well the thing would have to be very user friendly. That’s the point, that’s the hurdle.”

“So you look at it and think, ‘Oh, that looks nice’. And that’s what encourages you to probe further.”

“They want to take the easiest and most efficient route possible and they’re not into hanging around and exploration. They’re prejudiced. If it doesn’t look good they won’t engage.”

“It’s just like a grid of pictures that takes you to kind of interesting design things, and with a little bit of a description.”

**Inspiration**

“So I buy books with pictures of other designers work in as well as kind of, just for inspiration.”

“This is cool, this is a new thing that somebody’s doing, but it’s very rarely that it’s something that we can definitely use that with this project. It tends to be, it’s somebody who’s doing something inspirational.”

“There’s web inspiration, a lot of inspiration for the stuff we are doing is like looking
at trends, like what’s interesting right now, what people are interested in.”

“It doesn’t have to be in the same product category. It could be from somewhere else, you see a certain mechanism that works or a certain plastic that works and so you use that as a basis for your design. I think with product designers that’s typically the way that they work.”

“I don’t want to research materials right to the last point. Like designers are overall people aren’t they? They’re the jack of all trades designers. If someone is designing a car they’ll search for ‘cars’ rather than steel or whatever, that’s the way I would come at it.”

“It depends what stage you are in the process because if you’re writing a proposal then books, magazines, internet, on-line forums are really good at adding grit to your proposals.”

**Accountability/Traceability**

“Okay, so it’s got to be a balance between quick, easy to use, but at the same time you want to be sure the numbers it’s giving you. You want to be able to trace where the numbers are coming from. If you are making statements or judgements based on them you need to be able to back that up.”

**Miscellaneous**

“That means that then if you have certain links or whatever information that you think is valuable, you can access it anywhere. So that’s quite nice. So it’s not, y’know and we work remotely a lot so, or from home whatever, so y’know you can just log on wherever you are, and it’s there hanging in virtual space and you’ve got all your links.”

“The great thing about open source communities or forums, they’re dynamic and evolving, organic.”

“I find difficult just to surf the net in search for things. I mean obviously it’s easy in a way, and you can find lots of information, but a really good filter is through magazines and books.”

**Suggested Solutions**

“If you can have the equivalent of like the way Wikipedia works or the way the internet works or just a good website where you can dip into rich information, y’know linked information then maybe that’s a way of doing it.”

“A kind of forum will be a good idea, where it’s more like an open question, an
extension of what we do already with people we know, but on a bigger...in a bigger scale...yeah. That would be brilliant.”

“Maybe it’s about designing a collaborative online software like Google, Google Docs, where it’s less about the actual content and more about the medium.”

“So if everyone is using Illustrator, Photoshop, InDesign, like how do you building into that eco system as opposed to fighting it? And people are sending PDFs mostly because it’s the most robust way to share, especially designers when you are sensitive to your fonts staying true and all this stuff. It’s almost a good thing to assume people are using PDFs and think about how you can work within that environment. It might be interesting to look at how PDFs are getting better and better – I know they are adding features around three-dimensionality and stuff like that; does that give you any opportunities?”

**Warnings**

“DO NOT DO what they did at Cambridge [http://www.inclusivedesigntoolkit.com/betterdesign2/](http://www.inclusivedesigntoolkit.com/betterdesign2/) and inveigle your way into the whole process and do question and answers. They didn’t have any way of demonstrating how useful it was to everyone involved. They were like, ‘please pay attention to this’. You need some kind of way in.”

“What I DON’T want is a bible of detail.”

“Bad websites that you kind of go on and they kind of look like they haven’t been updated for about fifteen years; you think well if the website hasn’t been updated how reliable is this; especially if you’re looking for kind of up-to-date stuff.”

**Designer Websites**

[http://anthrodesign.com/blog/](http://anthrodesign.com/blog/)
[http://dirtymouse.net/](http://dirtymouse.net/)
[http://umproject.com/projects](http://umproject.com/projects)
[http://www.core77.com/gallery/](http://www.core77.com/gallery/)
[http://www.gizmodo.co.uk/tag/design](http://www.gizmodo.co.uk/tag/design)
http://www.thecoolhunter.co.uk/design
http://www.wired.co.uk/
https://www.frameweb.com/

Sharing Websites
http://digg.com/
http://www.flickr.com/
http://www.newsvine.com/
http://www.spaaze.com/home
https://delicious.com/

Ranking/Feedback Websites
http://en.reddit.com/
Trending Images - http://knowyourmeme.com/

Information Sources
https://www.newscientist.com/
http://www.ted.com/playlists/sustainability_by_design
https://www.economist.com/
https://www.wallpaper.com/

Video/Visual Sources
http://apps.npr.org/tshirt/#/title
http://www.theguardian.com/world/interactive/2013/nov/01/snowden-nsa-files-surveillance-revelations-decoded#section/6
Appendix Q: d.eco Wireframe Development
White buildings sink into the landscape at the Wolf hotel by AND-RE
A watery accident plays out in slow motion in Albert Sala’s music video for John Matthias
Appendices

**d.eco** WORLD | PRODUCT | RMaine

- **New**

- **Throwback Thursday: John Whitney's Animated Computer Visualizations From the 60’s**

- **Blee Halligan's Triptych house extension catches sunlight from three directions**

- **Family of candle holders created by Simon Legald for Normann Copenhagen**

- **White buildings sink into the landscape at the Wolf Hotel by AND-RE**

- **Monochrome marble tableware designed by Bethan Gray**

- **Family of candle holders created by Simon Legald for Normann Copenhagen**

- **Blee Halligan's Triptych house extension catches sunlight from three directions**
Appendix R: d.eco Development Modifications
Appendices

This geodesic houseboat cost less than $2,000 to build

Living a simpler life often starts with adjusting some daily habits, but for others, it can also mean swapping a big, cluttered house for the pared-down joys of a tiny house, treehouse or for water-lovers, a houseboat. While we've seen some rather pricey-looking modern and...

Select Relevant Topics Below

- Sustainability
- Energy Efficiency
- Water Use
- Materials
- Affordability

Info   Comments

Richard Mawle For the interior space, the shape of the large shed roof is directly exposed, and two angled walls (canted walls) are placed in this open-space. This simple design creates various interior spaces in both plan and cross-section.

Garrath Wilson I like to think that the duck in the background is going 'swaaawwawwww!'

Garrath Wilson A polite 'box in the garden' project formally well executed but devoid of any spatial tension or ambiguity.
Appendix S: d.eco Survey Visual Results

SurveyMonkey Cloud Text Analysis

Q7 In your own words, please explain if you think d.eco is visually engaging and whether this would influence your use of the website.

Clean visually engaging design

Q9 In your own words, please explain how you think d.eco might inspire you to incorporate EcoDesign into your work.

Think design useful blog relevant

Q11 Please explain how effective the format used in d.eco is at communicating EcoDesign principles, and showcasing products created using these guidelines.

Important community principles think

Q13 In your own words, please explain whether using the collective opinion of d.eco subscribers engenders a level of trust in the importance and/or information provided in articles.

Assuming wisdom of the crowd trust level importance community

Q15 Please give your overall opinion of d.eco, and whether you think it might be a useful tool for promoting EcoDesign.

Content stories ecodesign interesting eco design tool
NVivo Cloud Text Analysis
Appendices

SurveyMonkey Likert Question Response Charts

Q6 Please indicate how visually engaging you find d.eco.

Q8 Please indicate how useful d.eco could be in highlighting inspirational EcoDesign stories.

Q10 Please indicate how effective d.eco is at communicating information about EcoDesign.

Q12 Please indicate how reliable you consider the information provided by d.eco would be.

Q14 Please indicate how useful you think the principles demonstrated in d.eco could be in promoting EcoDesign.
Appendix T: Sample Questionnaire Transcript

The Practice of EcoDesign: A Study of Product Design Consultancies

Page 2: Your Information

Q1
What is your name?

Q2
What is your job title?

Q3
How many years of design experience do you have?

Q4
Where is your company located?

Q5
About how many employees work at your company?

Page 3: Visual Engagement

Q6
Please indicate how visually engaging you find de.eco.

Q7
In your own words, please explain if you think de.eco is visually engaging and whether this would influence your use of the website.

Page 4: Inspiration

1 / 3
Appendices

The Practice of EcoDesign: A Study of Product Design Consultancies

Q8
Please indicate how useful d.eco could be in highlighting Inspirational EcoDesign stories.

Very useful

Q9
In your own words, please explain how you think d.eco might inspire you to incorporate EcoDesign into your work.

If EcoDesign can stand apart from existing blog websites who are not specifically targeting the EcoDesign arena then it will be great.

Page 5: Communication

Q10
Please indicate how effective d.eco is at communicating information about EcoDesign.

Effective

Q11
Please explain how effective the format used in d.eco is at communicating EcoDesign principles, and showcasing products created using these guidelines.

It's an effective strategy linking to an existing story/website with the story on it.

Page 6: Accountability

Q12
Please indicate how reliable you consider the information provided by d.eco would be.

Reliable

Q13
In your own words, please explain whether using the collective opinion of d.eco subscribers engenders a level of trust in the importance and/or information provided in articles.

Assuming only those interested in the topics will engage with the site, I think the importance of the articles could be reliable. There is the risk of very important articles being pushed out of sight by those with less substance but seen as more fashionable.

Could there be a specific journal section? Linking peer reviewed journal papers away from sexy articles/topics published on sites such as core77 and co.

Page 7: Overall Opinion

2 / 3

300
### Appendices

The Practice of EcoDesign: A Study of Product Design Consultancies

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<th>Please indicate how useful you think the principles demonstrated in d.eco could be in promoting EcoDesign.</th>
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<th>Please give your overall opinion of d.eco, and whether you think it might be a useful tool for promoting EcoDesign.</th>
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<td>I think it is a good idea and will be very successful assuming it is pushed through social media appropriately. Great catch with the domain name. Perhaps need to increase its visibility when searching for 'eco design' in google etc.</td>
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Page 8: Thank You

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<th>Would you be willing to be contacted for a follow up interview?</th>
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<th>At what email address would you like to be contacted?</th>
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<th>Do you have any other comments, questions, or concerns?</th>
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