Learning from Green Technology Designers

by

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Author's declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Even prior to the emergence of designers as technology professionals, researchers have been studying how technology designers think, and more specifically, how they think differently than non-designers [6][25][34]. As designers have become critical components to the creation of technology, an understanding of the discipline of design has become of significant interest within the field of Human-Computer Interaction (HCI).

Alongside an interest in design, HCI has seen work driven by the perspective of sustainability. However, very little of the research in sustainability has looked at how designers think through the lens of sustainability. This lack of reporting comes at a time when design thinking has emerged as one of the most significant ways to curb environmental degradation. By looking at how environmentally minded designers 'think' differently than traditional designers, other technology professionals may be able to benefit and take their own innovations to a higher level.

This thesis presents results from a qualitative case study on environmentally minded technology designers, and provides an account of how these designers think, differ and behave. Through semi-structured interviews, we interview designers at a large mobile phone manufacturer. The responses of environmentally minded designers are contrasted with traditional designers. The findings lead to a discussion on the differing roles, tradeoffs and standards between these two groups of designers.

At the core of this thesis is a more informed view of the nature of green designers. For the same reasons that we study art, understanding the process helps us train new people gifted in the art of design. Understanding how designers think, and especially how 'green' designers think differently, helps better prepare future designers to look at problems in the sustainability space. Other designers may draw on this research to design more sustainably, and take their own problem solving abilities to a higher level.

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To the community,
our children
our children's children
and
all species of all time.

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1 Introduction

For the first time in history, it is recognized that our current lifestyles cannot sustain the environment that sustains us. In the next ten years, eight hundred million people will be added to the global population [40]. Environmental problems such as global warming, acid rain, pollution, ozone depletion and deforestation will become more pervasive than ever before. The global climate crisis will have changed the habitats of many living species so that they can no longer survive [42]. The variety of environmental issues facing the planet is considerable.

Addressing the sustainability of the planet requires everyone's involvement, especially technology designers. Technology designers are in a direct position to shape people's behavior. Mobile technology for instance, has allowed designers to create applications that favor public transportation over driving, reduce people's energy usage as well as encourage recycling and re-use, over disposal [43]. Adopting a perspective of sustainability reframes what technology designers do. Designers must be equipped to ask questions such as "Is this the morally right thing to do", "What is needed versus wanted?" and "What are the potentially unintended consequences?" They must be able to think differently and make deliberate choices about the utility of things, the materials used, the manufacturing process, the length of useful life, and what happens after a system is no longer needed [9].

The field of Human-Computer Interaction (HCI) has seen work driven by the perspective of sustainability. However, very little of this work has looked at how the perspective of sustainability changes how designers think and what they do. As reported by DiSalvo *et al.*, only 10% of the proceedings at the Computer-Human Interaction conferences look at the role of design (and designers) in creating more sustainable technologies [8]. This lack of reporting comes at a time when design thinking has emerged as one of the most significant ways to curb environmental degradation. It seems sensible then, to draw upon the accounts of designers to pose more effective and fruitful research questions that would encourage sustainable outcomes.

1.1 Research Questions

In the field of HCI, few empirical studies have looked at the changing role of the designer through the lens of sustainability [8]. This lack of reporting comes at a time when design thinking has emerged as one of the most significant ways to curb environmental degradation. Designers are in the perfect position to consider how products, services and the built-environment can be designed to lower the barriers towards pro-environmental behaviors such as recycling, reduced energy use, reduced consumption, etc. By interviewing green designers, and contrasting their responses with traditional designers, we may learn about the practices of green designers and discover new or unusual ways of thinking that may benefit technology designers and the HCI community at large.

This thesis presents the results from a qualitative case study on environmentally minded technology designers at a large mobile phone manufacturer. Through semi-structured interviews, the responses of 12 environmentally minded designers are contrasted with 10 traditional designers, focusing on how environmentally minded designers employ their problem-solving skills differently than traditional designers.

We explore the practices of green designers through a series of open-ended questions:

- What motivates technology designers to adopt the perspective of sustainability?
- What are the new roles and responsibilities of designers when incorporating sustainability into their work?
- How do environmentally minded designers employ their creative skills differently or similarly than traditional designers?

1.2 Study

In order to answer these questions, research techniques were carefully chosen to gain insights on the practices of technology designers. In the field of HCI, both qualitative and quantitative methods are used to explore questions relating to technology and human behavior. When asking particular research questions, an appropriate method of inquiry must be chosen. As described by Basili *et al*, researchers must properly "choose the evaluation paradigm and techniques to answer the questions" [1]. While Basili *et al.* was referring to the DECIDE framework that helps novice interaction designers choose an appropriate research method to evaluate technology systems, this statement equally applies to all methods of inquiry in HCI.

The question at the core of thesis is how do the practices of environmentally minded technology designers differ from non-green designers. To describe this difference, an in-depth understanding of design practices must be examined, requiring a qualitative approach. It would be premature to attempt to quantify these differing traits in design practice before having an understanding of what those practices are, and how adopting a sustainability perspective influences those practices. To describe environmentally minded design practices than open-ended exploratory techniques are more appropriate then close-ended, focused experimental questions.

An in-depth understanding of designers in a real-world context was crucial to the success of our study. Conducting a case study was particularly appropriate in providing rich and insightful descriptions of phenomenon as well as accessing professional designers in an industry setting. All together, 22 designers were interviewed from the disciplines of visual, interaction and industrial design as well as user research.

1.3 Findings

Through analysis of the interview data, we form a rich picture of the ways in which green designers employ their creative skills differently than traditional designers. These differences are grouped into three broad themes. Each theme forms a chapter of this thesis:

- Chapter 5: The Sustainability Lens
- Chapter 6: Roles and Relationships between designers and their stakeholders
- Chapter 7: Intuition & Uncertainty in Design

The first theme, the sustainability lens, reports on the motivations of participants for being 'environmentally minded'. Designers cited a transpersonal orientation as one of the main sources for their commitment to a sustainability perspective – that is, they were often motivated by a source that transcended themselves. "Doing good" was described as their life's calling. Other participants offered a slightly different response. For some, it was about "acting on behalf of their users" or humankind. This personal commitment to sustainability appears to influence the design process in a profound way. In contrast to traditional designers, for green designers it confines excitement around the novelty of the technology, it makes the design process less divergent and creates a wider design lens for designers to look at their own work.

The second theme, the roles and relationships of designers, concerns itself with the participants' relationships to peers, managers and stakeholders. Environmentally minded designers reported adapting to different roles throughout the design process, as needed. The roles typically fell into three categories: facilitator, supporter and catalyst. In the role of 'facilitator', designers reported attending to the varying opinions of management, while reserving judgment. In the role of supporter, designers actively took sides on what solutions would be best for their users. In the role of 'catalyst', designers were a force for change. Within these three roles, green designers tended to take on a more adversarial role than traditional designers. Green designers tended to push boundaries and be advocates for the environmental. In contrast, traditional designers tended to mediate between the needs of business, their users and green designers.

The third theme, intuition and uncertainty in design, describes two different ways of working among green designers. Green designers tended to rely on unusual ways of knowing. Channeling 'instincts' and 'gut' were some of the words that described how participants accessed sources of knowledge. Traditional designers, on the other hand, felt like they needed to support their choices with user research and rationalize their ideas with facts rather than opinions. Green designers also tended to embrace 'uncertainty' as a significant part of the design process. Acknowledging uncertainty seems to offer something valuable and quite positive in solving problems.

1.4 Discussion

As we examine the three themes that emerged from the interviews, the main question we ask is how the roles of green designers and traditional designers differ during the design process. In this section, these differences are grouped around three particular themes: differing roles, differing trade-offs and differing standards.

The first difference we look at is between the roles of green designers and traditional designers. We discuss how the advocacy role that green designers serve is simultaneously more liberating and more challenging. The tolerance for uncertainty allows green designers to question and to fail in a way that traditional designers are uncomfortable with. Furthermore, green designers were able to draw inspiration from themselves, as opposed to grounding data in design.

The second difference we look at is the differing trade-offs of green and traditional designers. Green designers articulated trade-offs that included a need for patience and a need to understand when to advocate and when to step back and listen. Traditional designers on the other hand, were clearly aware that, in their role, where the goal of design was a final, profitable artifact, the laudable goal of environmental sustainability had to be balanced with the needs of the business.

The third difference we discuss is differing standards between green and traditional designers. All of the designers we spoke with cared deeply about the products they designed, but the green designers were unique in the ownership they took of their personal investment in design as a process, describing comfortably the spiritual aspects they brought to design. "Good" green design is both a pragmatic and an altruistic endeavor. In contrast, traditional designers measure their success in the practicalities of the real world, specifically metrics such as how many units shipped, or the differential between the price of the product and the cost of the product.

1.5 Implications & Contributions

This thesis presents findings from a study on the practices of green technology designers, and compares those practices to those of traditional designers. The results in the study uncover how the practices between these two groups of designers differ. Readers should gain an appreciation of how creative thinking skills may differ when adopting the perspective of sustainability when designing a technology system.

At the core of this research is a more informed view and research-based understanding on the nature of 'green' design thinking. It is an ill-defined space, but, for the same reasons that we study art, understanding the process helps us train new people gifted in the art of design. Understanding how designers think, and especially how 'green' designers think differently, helps better prepare future designers to look at problems in the sustainability space. Other designers may draw on the thinking techniques and themes discovered to design more sustainably, and take their own problem solving abilities to a higher level.

Furthermore, a rich description of a particular use case offers rich details for anyone interested in green designers. This case study provides a holistic account of the phenomena of green design. It offers insights and narratives that may illuminate a readers understanding, especially because not much has been written about green design. The case study may also offer tentative hypotheses in which other researchers could extend the work.

From the findings of the study, we may start to ask questions about design education. Traditional design education has always empathized with the user. However, it has not always taught about how to care for all stakeholders at hand, namely the interrelated environment and social welfare. We may look at the ways in which design education can be enhanced by asking the following questions:

- Is the current design education system aptly training individual to solve ill-defined problems such as issues of sustainability?
- Is it preparing future generations to appreciate the growing complexity of relationships between people, the environment, and technological systems? If not, how should it change the education system itself?
- How can value-based notions of well-being and caring for the planet be taught, if sustainability is to become inherent in all design practices?

1.6 Organization

Chapter 2 of this thesis sets the scope of this research and reviews existing work in the field of Human-Computer Interaction.

Chapter 3 looks at existing work conducted on designers. We familiarize the reader with the role of technology designers and with concepts such as design thinking.

Chapter 4 describes the methodology for conducting the research. We describe the selection criteria for choosing participants, the approaches to collecting the data and the data analysis techniques.

Chapter 5-7 present the findings of the study, namely; the personal nature of design, the roles and relationships between designers and their stakeholders and intuition in the design process.

Chapter 8 discusses three crosscutting observations from the data, namely; the differing roles, standards and trade-offs between green and traditional designers.

Chapter 9 concludes with a summary of findings and implications for future work.

2 Background

Although sustainability has been a long-standing concern for the environmental science community, it is a relatively new topic to the discipline of Computer Science [4] and thus warrants an introduction. We provide a timeline of events that highlight sustainability's relationship with technology design. This leads to an understanding of how technology design has become synonymous with issues of sustainability.

We then establish a working definition for the term 'sustainability' and highlight existing approaches such as such as lifecycle assessment, slow design and co-design. The challenge to incorporate sustainable design practices becomes clear and raises the question of how the field of Human-Computer Interaction may support additional research in sustainable design thinking. Finally, we explore the landscape of environmental discourses in the context of technology design through the field of Human-Computer Interaction (HCI). We look at the discourses of eco-feedback, persuasive design and sustainable interaction design (SID) as a basis for our research.

2.1 Historical Context

Our research can be better understood with the acknowledgement of key events, publications and legislation driving sustainable product design. Through much of the 20th century, technology designers played a critical role in western economic growth and created systems that made people's lives easier. An unanticipated consequence of this commercial success was a consumerist culture based on disposability and planned obsolescence. By the end of the 20th century, many designers created products that were highly desirable, luxurious and 'cool'. This narrowly focused their work on desirability rather than on creating happier and healthier lives. This also created the trend towards short-term fashion cycles, rather than providing long-lasting, durable value.

The publication of Rachel Carson's book, *Silent Spring,* is often cited as the start of the sustainable design movement [43]. Carson's book represented an assembly point for the social and environmental movements of the 1960s. Her work influenced the formation of groups such as Greenpeace and Friends of the Earth, as well as the policies of governmental bodies such as the Environmental Protection Agency. More importantly, her efforts drove demand for product transparency which lead to a design movement around product sustainability.

Inspired by Carson's work, architect Buckminster Fuller was one of the first to openly criticize the design profession for creating permanent garbage and pollution. Fuller challenged designers to become ecologically and socially responsible [35] and promoted resource conservation through a

principle coined "dymaxion" which gave the maximum human benefit from the smallest use of materials and energy. Prominent designer Victor Papanek also blamed designers for the world's environmental problems [30]. Papanek urged designers to help "change, modify, eliminate, or evolve totally new patterns […] by considering the needs of people." For Papanek, serving the real needs of people meant things should be designed with the environment in mind.

For a long time, issues of sustainability were referred to as 'socially responsible design', in the field of Design. In the 1960's, Victor Papanek discussed the idea that creative professionals have the responsibility to create or re-create things that are of benefit to society and the planet [30]. Papanek writes about how it should no longer be acceptable to simply satisfy people's wants, but rather, ways must be found to improve lives of everyday people, while at the same time not harming the environment. This is perhaps the first instance of when environmental issues were brought to light.

Shortly after Papanek's publication on *Design for the Real World* [30], many other designers began looking at environmental degradation and blamed designers for creating highly toxic, environmentally harmful, disposable items. This view became essential to the field of design, as it acknowledged that a new paradigm for creating things was required in order to create a healthier planet. There was a need to look at new methodologies and ways of thinking that would create less harmful things.

Pro-environmental design emerged as a new area for designers. However, the set of attributes that made a product healthy or safe for the environment was unclear. Eco-design marked the first attempt to systematically integrate an environmental perspective into the design of artifacts. Concrete strategies were outlined to help designers reduce environmental impacts, such as minimizing resource consumption, use of low-impact, non-toxic materials, use of durable materials that resulted in less frequently replaced product, energy efficiency during the manufacturing process and design for re-use and recycling. By the 1980's, tools such as the EcoDesign wheel [43] became widely used to improve product performance through goals of resource efficiency.

Rather than solely being about aesthetics, design was slowly going to evolve to become about solving real-world problems. By the 1980's, wider demand for "environmental-friendly" products encouraged designers to pay attention to the environment. However, many industries took advantage of the public, by deceptively labeling harmful products as "environmentally-friendly". Unsubstantiated product claims and greenwashing marketing tactics soon resulted in a cynical public where more pro-environmental products were obscured in a landslide of market-driven, environmentally harmful goods [16]. As a result, many organizations continued to rely on traditional design methods and lacked the incentive to produce less harmful products.

As evidence for global climate change mounted, a report prepared by the Brundtland Commission, in 1987, outlined dangers of the planet's current trajectory. The report called for planetary sustainability: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [46]. This definition of sustainability was important for two reasons. First, it originated a fundamental principle of the present generation being

responsible for future generations. Second, it combined the word "development" with "sustainable" to indicate development, as it was known, was no longer possible.

By 2002, a new way of thinking arose, about how to design and create things. This way of thinking became known as the Cradle-to-Cradle perspective [28]. The theory proposed industrial processes as a closed loop system where materials could be reintegrated into a new or different system, once the old system was done being used. This way of thinking was probably been the most significant outcome of design research. It models human consumption based on nature's existing process of always viewing materials as nutrients for something else.

Sustainability increasingly became synonymous with issues of product design. In the most recent decade, we see significant consumer pressure, and regulatory directives such as Waste Electrical and Electronic Equipment (WEEE), Restriction on Hazardous Substances (RoHS) and Registration, Evaluation, Authorization and Restriction of Chemical substances (REACH) to create less environmentally harmful products. These emerging regulations have required designers to develop new capacities in their product development process, as well as employ strategies to reduce environmental impacts through the minimization of resource consumption, use of environmentally preferred materials, and design for re-use and recycling.

For some designers, product sustainability has become a mantra, expanding the role of traditional design to an integrated activity with complex considerations. A wider range of factors began to be considered in product design, such as renewability and eco-toxicity, many which lie outside the domain and expertise of conventional designers. Regulations have pressured businesses and designers to evolve their capabilities and methods towards product sustainability. Trends suggest that businesses negligent to product sustainability are discrediting brands and even reducing market share. Brands at the forefront of sustainable product design are seeing increased customer loyalty and greater growth opportunities [11]. Companies such as Apple Inc, have highlighted this renewed approach to "green" design, as key to their success [38].

This historical context suggests substantial changes to how products are designed. However, it may still be unclear what is meant by sustainability in the context of our research. In the next section, we review a definition for sustainability, and explain its three complimenting dimensions. This forms a mutual understanding for our research.

2.2 Sustainability: A Working Definition

Sustainability can mean many things to many people, and thus requires an extended explanation of what sustainability means in the context of our research. A broad definition for sustainability was defined at the 2005 World Summit as three reinforcing and interdependent pillars: economic development, social development and environmental protection [41]. This is perhaps the most widely used understanding of planetary sustainability.

In our research, the three pillars of sustainability represent a more systematic framework by which research questions can be examined, instead of through the all-encompassing lens of sustainability alone. When discussing sustainability, we are careful to note which pillar is being referred to - environmental, social or economic. If all the dimensions of sustainability are being discussed, then we simply refer to the more inclusive term of sustainability that refers to all three pillars.

The International Union for Conservation of Nature (IUCN) proposed a visualization of overlapping circles to indicate that these pillars of sustainability are not mutually exclusive [41]. In this section, we describe each of these pillars. We also describe a fourth pillar that is sometimes mentioned, cultural sustainability, and group it with the pillar of social sustainability. Furthermore, we also explain other terms that the reader may be unfamiliar with, and explain our choice for using this three pillars framework.

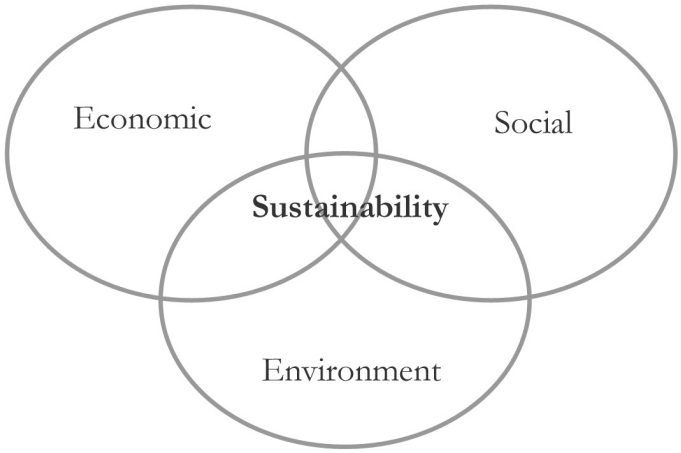

Figure 2.1 - Scheme of sustainable development indicating the convergence of three pillars

2.2.1 Environmental Sustainability

The first pillar, and the one most often referred to is that of **environmental sustainability** [41]. Environmental sustainability refers to a condition where human activity does not disrupt nature. This requires that natural resources be used at a rate whereby they can be replenished fully and naturally. An unsustainable situation occurs when nature's resources are used up faster than they can be replenished.

Aspects of environmental sustainability include;

- Maintaining biodiversity
- Atmospheric stability
- Consumption of renewable resources equal or less than nature's ability to replenish

Environmental sustainability requires a system that operates with resiliency and adaptation to change [27]. The idea of resiliency is often missed because it's fairly abstract. Often, lower-level elements that contribute to system resiliency are the focus. However, problems must be approached with resiliency in mind are more likely to last, grow and respond to changes. In ecological terms, some things that have affected ecosystem resilience are reduced biodiversity, exploitation of natural resources, climate change, land use and pollution.

2.2.2 Social Sustainability

In contrast to environmental sustainability being driven by irresponsible stewardship of the planet, **social sustainability** responds to the accomplishments of the last century. It refers to the progress of human rights and developments in science that have lead to increased quality of life [41]. Social sustainability encompasses the following ideals:

- Equity for all, particularly the most vulnerable and poor
- Promotion of diversity
- Social cohesion of communities
- Basic needs are met such as housing, education, employment and health
- Democracy and accountable governance systems

In social terms, resiliency refers to fostering education, redundancy through overlapping social networks, encouraging adaption and strong social cohesion. Here, social sustainability is applied to a broad range of challenges that reach far beyond environmental outcomes. The focus is on promoting healthy societal behaviors, actions and attitudes, as well as developing the skills of people.

2.2.3 Economic Sustainability

The third pillar, **economic sustainability,** refers to the monetary aspects of sustainability [41]. Although conventional economics is typically concerned with growth and distribution of resources, economic sustainability has the goal of fair distribution and efficiency. Any economic growth that degrades the environment is seen as uneconomic growth.

In economic sustainability, total cost accounting is typically used to provide a more complete assessment of the true costs of a system, by taking into account direct and indirect environmental impacts and savings [23]. Longer time horizons are used, such as the complete lifecycle of a product, reflecting hidden costs that are usually externalized by companies.

2.2.4 Other Pillars & Terms

The term "sustainability" sometimes inadequately describes the way people relate to the environment. Thus, sometimes, other nouns are used to describe sustainability, such as 'green'. For the purposes of our research, the term 'green' may be used interchangeable with the word sustainable.

Some sustainability literature refers to a fourth pillar, **cultural sustainability**. This pillar refers to the preservation of local heritage, creativity and knowledge, and highlights indigenous cultures and developing countries, often in the context of development. By making culture a separate pillar, it raises the significance of local factors in general, and raises the role of art, creativity and community development.

Although culture is an important aspect to sustainability, the role and meaning of this pillar is less defined than the other three pillars. Not very many policy documents have referred to this pillar [19]. Furthermore, in the sciences, research rarely examines sustainability through this lens. For this reason, we group this pillar with that of social sustainability, and research issues of culture in terms of social cohesion and equity.

2.3 A Vision for Technology Makers

Shortly after these three pillars were proposed, in 2005, William McDonough and partners established a vision on how the makers of products, services and systems can comply with the principles of social, economic and environmental sustainability outlined by the Brundtland Commission [29]. This vision was not exclusively meant for technology designers, but rather anyone who creates everyday artifacts.

The Hannover Principles remains the clearest and most succinct vision for sustainability. The principles place importance on the environment and social sustainability, at the core of professional design practices. The principles emphasize continual improvement of practices and processes towards sustainable outcomes. This vision may be viewed as inadvertent approach to technological design, where product makers may not deliberately set out to achieve a 'sustainable design' but instead, synchronize with some of the principles in this vision; reduce material usage, create safe objects and act responsibly for the well-being of the planet. Applications of the principles range from the objects produced for everyday use, to edifices, communities and the planet's physical shell. In our research, designers indirectly referred to the principles in this vision.

For convenience, we outline the Hannover Principles vision for sustainable design below [29]:

> *"1. Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition.*
>
> *2. Recognize interdependence. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.*
>
> *3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.*
>
> *4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems and their right to co-exist.*

5. Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes or standards.

6. Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems, in which there is no waste.

7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.

8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.

9. Seek constant improvement by the sharing of knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity."

This vision is often viewed as an explicit design strategy requiring a specialized approach to the design process – an additional strategy taken when developing products or experiences. In our research, we encountered many technology designers who took on specialized approaches to design. In the next section, we review some these approaches, and attempt to familiarize the reader with the topic of sustainable design.

2.4 Sustainability & Technology Design

In our study, we examine the practices of technology designers through the critical lens of sustainability. Although sustainability research has had the widest audience in the environmental sciences [8], the interconnectedness of issues like climate change and technology has allowed computer scientists to also look at issues of sustainability. The field of Human-Computer Interaction in particular, has looked at how objects can be created or repurposed with minimal impacts to the environment. Manifestations of HCI research look at renewable resources, the connection people have to the environment and objects, as well as behavior shifting , however with a focus on technology and on how technology can enable sustainable outcomes. We briefly review these areas of research and related discourses.

Over the last decade, the field of Human-Computer Interaction has been described as a juncture of two movements [32]. The first movement involves computing and the use of computing tools to manipulate information within a broad scale of time and space. Digital technology brings many opportunities for HCI designers, especially now with mobile technology widely utilized. The second movement involves a move towards human usability in computing systems. The move towards usability often find its way in the form a novel user interface or computational system.

The field of Human-Computer Interaction (HCI) brings these two areas together, technology and user-centered design, and explores the ways in which they are connected. Methodologies in this field manage the experience and expectations of users, and research commonly measures the user's satisfaction with a given system.

When discussing HCI, Hopper, Rice and Beresford describe how "computing could become be a positive force for reducing the environmental impact of humankind" [18]. The field of Human-Computer Interaction (HCI) has seen a surge of workshops, interest groups and conference publications addressing issues of sustainability [15]. Increased research in the area has led to reflective conversations about the role of technology in mitigating environmental problems [45]. HCI designers can help people participate in many ways to address environmental degradation. For instance, technology can help people become more aware of their consumption behaviors. This form of a participation could be as simple as reading something on a mobile website. It could also be more complex, such as offering a platform whereby people can carpool with strangers to reduce their consumption behaviors.

Eli Blevis' paper on 'Sustainable Interaction Design: Invention & Disposal, Renewal & Reuse is perhaps the most referenced paper on environmental discourse in HCI [4]. Blevis presents the perspective that sustainability should be a central focus in the field. He situates HCI designers at the locus of accountability for environmental degradation. This approach is markedly different from anthropocentrism, and does not put people above all other species. Rather, it sees humans, and especially technology designers, as having the greatest potential in responding to the environmental crisis.

With this increased awareness in environmental issues, four kinds of environmental discourses have emerged: eco-feedback, captology, collapsed informatics and sustainable interaction design. In the next section, we review these discourses in an attempt to situate on our own work. Our goal is not to present a single definitive clustering of existing work. Rather, we provide four lenses for which research can be understood. We describe (1) the primary categories of work, or common discourses that structure how researchers situate the problems they are trying to solve; (2) the general differences between the categories of work, and; (3) emerging criticisms in each area, and where our research can contribute.

2.4.1 Eco-Feedback

Eco-feedback refers to both the technology as well as a particular area of research that attempts to reduce environmental impacts through audio, visual or tactile feedback propagated through the user's environment [13]. The design of the technology is based on the assumption that people lack the awareness to understand their consumption behaviors (ie. electricity usage, water, etc). By consolidating and visualizing consumption behaviors, users are exposed to the resources they consume. The fundamental conjecture is that consolidation and visualization of the consumption data will generate an increased awareness of consumption behaviors and therefore encourage pro-environmental behaviors.

The main criticism of eco-feedback technology is that this feedback is not always enough, especially for more valuable consumption savings. Gardner and Stern explain that eco-feedback does not always curtail environmentally unfriendly behaviors [14]. For instance, in the case of home lighting, remembering to turning off an incandescent light bulb through an eco-feedback system would not be as effective as installing compact fluorescent lights. Feedback may be valuable as an in-context self-learning tool, however, the outcomes can vary quite drastically according to the circumstances.

Deciding where and when to present the information is extremely complex. Many energy conservation programs use prompts on bills. However, prompting strategies have been showed to be only effective when improving timing and placement. For instance, placing posters next to light switches with specific information about when to turn off the light switch, has been show to be much more effective than placing generic messages about saving energy. Eco-feedback technology can go a step further and provide feedback proximal to the location and time of the target behavior.

An even larger criticism of the eco-feedback discourse has only been touched upon in existing literature. Eco-feedback places emphasis on the resulting technology rather than the methods by which the technology is designed [14]. By placing importance on the end-result, it negates the importance of how we can improve the design process to lead to more pro-environmental outcomes. Understanding the nature of design thinking, and influencing that design thinking, is perhaps the most effective way to curb environmental degradation. Captology goes one step further than eco-feedback and attempts to change what people think or do. Here, designers can attempt to increase an individual ability to perform a target behavior, such as recycle or use energy more efficiently. In the next section, we review this research area.

2.4.2 Captology

When looking at the history of computing, it is easy to find products that have changed the way people think or behave. Most of these technologies were not planned effects of the designer. Rather, captology looks at how designers can intentionally persuade users towards a certain behavior. This approach assumes the designer can choreograph the user's experience, and support the motivations and desires of users, regardless of whether the designers' values align with their users.

The designer can persuade the users on two different levels – macro and micro. Micro persuasion occurs when the outcome of the persuasion stays within the interaction of the user and technology at hand. For instance, dialog boxes can persuade users to complete tasks. They can also persuade users to stay within the application for longer. Macro persuasion occurs when the outcome goes beyond the technology at hand. Macropersuasion is typically what designers refer to, in the case of pro-environmental outcomes.

B.J. Fogg explains a framework in which designers can think about how their work persuading users [12]. The framework is coined the 'functional triad', and consists of three roles that technology can play; tool, media and social actor. These three functions attempt to explain how people respond to any technology product. This triad helps designers understand the nature of what they are creating

and often brings clarity to analyzing the solution at hand. Designers can ask themselves how the technology may persuade users as a tool, sensory media or social actor.

In the functional triad, technology can play three roles. The first role is that of a tool. Technology can make activities easier to do. They can lead people through a process or help them perform calculations that improve motivation. For instance, technology here can lead people through a wizard to identify barriers in having a healthier life. The second role is that of a media. Technology can simulate experiences and allow people to rehearse behaviors. It takes the risk out of performing the behavior for the first time. For instance here, people may be able to rehearse what it might be like to have a healthier life. Thirdly, technology can act as social influences. It can positively reward people and provide the necessary social support for the targeted behavior.

This triad has many practical applications for designers, and for those who need to understand the impacts of their designers. However, many designers might not be willing to persuade users, particularly if they have the view that persuasion consists of 'invisible' manipulation. If the user is unaware of the choices made in the design of the technology, and the persuasion element is not a visible element to the user, there may be ethical implications for certain designers. Furthermore, this puts designers in a direct responsibility to make a judgment ie. - Will the design be on the side of social good or not? Many designers are not willing to be put into such a position.

2.4.3 Collapsed Informatics

Collapsed informatics is the most recent discourse in the field of HCI, relating to sustainability [39]. The label of 'collapse' assumes that environmental challenges will gradually result in a collapse across communities. Tainter describes the collapse as a "rapid, significant loss of an established level of sociopolitical complexity. He describes the characteristics of a collapse as follows [37]:

- *"a lower degree of stratification and social differentiation;*
- *less economic and occupational specialization, of individuals, groups, and territories;*
- *less centralized control; that is, less regulation and integration of diverse economic and political groups by elites;*
- *less behavioral control and regimentation;*
- *less investment in the epiphenomena of complexity, those elements that define the concept of 'civilization': monumental architecture, artistic and literary achievements, and the like;*
- *less flow of information between individuals, between political and economic groups, and between a center and its periphery;*
- *less sharing, trading, and redistribution of resources;*
- *less overall coordination and organization of individuals and groups;*
- *a smaller territory integrated within a single political unit"*

The field of study in HCI proposes the need for researchers to create technologies that would support and mitigate the impacts of a collapse. This is quite different than the discourses of captology and eco-feedback in HCI that primarily focus on mitigating environmental impacts. Collapse informatics is a wider notion and concern for the planet.

Our research only touches upon issues of collapse. For the most part, our participants remain optimistic about the future and do no feel a need to prepare for the worst. However, this area of HCI is still worth noting, as we discuss it in our future work section, and hypothesize on how future work can contribute to notions of collapse.

2.4.4 Sustainable Interaction Design (SID)

Finally, we look at the discourse of Sustainable Interaction Design. The process by which technology is created, allows HCI designers to have some control over how it will be used. Throughout the design process, many aspects of the product can be manipulated – such as functionality, the physical or digital interface and documentation. This influences how people use the product, and what they do when they are finished using the product. Sustainable Interaction Design looks at scholarship within design and critical studies, and determines what the role of design is in current environmental challenges.

Two pieces of literature are critical to this area of research. The first piece of literature is Eli Blevis' perspective paper entitled Sustainable Interaction Design: Invention & Disposal, Renewal and Reuse [4]. Prior to this paper, HCI literature only addressed environmental sustainability. Blevis expanded the notion of sustainability to include social equity and economic sustainability.

Furthermore, Blevis brought issues of sustainability to the forefront of HCI research. Blevis borrows ideas from ecology and the field of design to evaluate the changing course of action in HCI towards sustainability. As a short summary, Blevis identifies five design opportunities for HCI professionals: *linking invention and disposal, promoting renewal and reuse, promotion quality and equality, de-coupling ownership and identify, using natural models and reflection.* These principles tie together important aspects of the HCI profession such as material selection, the lifecycle of technology products and social equality. Blevis' paper has focus on HCI designers and their ability to create things that are healthier for the planet. However, it still remains unclear how HCI professionals may execute on these five opportunities.

A more concrete guide to action was published by Huang and Truang on opportunities for sustainable mobile phone development [21]. This brings to attention the long-term impacts of technological design, such as mobile phone usage. Huang et al brings to attention the current paradigm of disposability of technology. This paradigm is "characterized by technology that comes with the expectation of a short usage lifetime, despite the potential for a longer functional lifetime" [21]. In comparison to older technologies, Huang reveals how the problem has only gotten worse over the last few decades, especially with mobile phones. Users are used to replacing their phones every 6-12 months, compared to other technologies that may have lasted a decade or more, in the home of users.

The transition from eco-feedback all the way up to sustainable interaction design, represents a steady broadening of scope of sustainability research in HCI [4]. To a certain extent, a critique of the discipline of HCI itself can be observed, blaming HCI professionals for not consider the long-term impacts of technology. HCI research introduces (or re-introduces) the idea of responsibility and ethics in the field of computer science, using a much broader notion. Thinking about the entire lifecycle of technology is profoundly important if we are to make things more sustainable.

2.5 Summary

Because of the many disciplines involved in issues sustainability, an extended understanding was required. We outlined three events that described how sustainability became synonymous with issues of product design; (1) the industrial revolution created products that were highly desirable, luxurious and 'cool'; (2) Rachel Carson's book, *Silent Spring* as the start of the sustainable design movement; (3) the EcoDesign wheel which improved product performance through goals of resource efficiency, and; (4) regulatory directives such as WEEE, RoHS, and REACH that aim to create less environmentally harmful products.

This lead to a working definition of the term sustainability. The IUCN's scheme of three converging pillars was explained as a framework in which to analyze issues of sustainability. Besides economic, social and environmental sustainability, we noted a fourth pillar, cultural sustainability that is grouped with social sustainability for the purposes of our study. We then outline a vision for technology designers.

The challenge to incorporate sustainable design practices becomes clear and raises the question of how the field of Human-Computer Interaction may support additional research in sustainable design thinking. We described the four primary categories of work; eco-feedback, captology, collapsed informatics and sustainable interaction design. This provided the necessary structure for us to situate our research.

3 Design & Designers

Recently, in the field of computer science, designers have emerged as legitimate technology professionals. New designerly roles such as interaction design and user interface design influence the construction of technology products or systems. These designers look at how to design interactions between people and computers that are receptive to people's needs, and have a minimal barrier between people and computers.

Here, we provide an overview of the discipline of design as well as the role of designers. Because design and designers is a relatively nascent area of research in computer science, we give an overview of what is design, who are designers and how they influence the design of a technology product or system. We describe their roles and common traits, as well as outline existing research on the design process.

3.1 An Overview

While technology may be thought of as an outcome of human actions, it is important to remember that technology is designed by people. The process by which something is created, allows technology designers to have some control over how it will be used. Throughout this process, many aspects of the product can be manipulated – such as functionality, the physical object or interface. This influences how people use the product, and what they do when they are done using the product.

For the purposes of our research, we have a very specific understanding of the term 'design'. Since the word 'design' is used throughout this research, it is important to describe what design means. The very word 'design' can be problematic, as it is both a noun and verb. As a noun, it can refer to the resulting system, product or service that was created. As a verb, it can refer to the journey of how something was created. In our work, we are typically not concerned with the resulting 'design', but rather the 'design' journey that is taken to achieve the end-result. Hence, when we use the word 'design', it typically refers to the journey or process by which something is created.

More formally, the word 'design' has been described as follows. The word *specification* refers to a plan of how a system should be created. This is the definition we use for the purposes of our study:

> *"A roadmap or a strategic approach for someone to achieve a unique expectation. It defines the specifications, plans, parameters, costs, activities, processes and how and what to do within legal, political, social, environmental, safety and economic constraints in achieving that objective" [9].*

3.1.1 What Designers Do

Cross identifies six key aspects to a designer's job: solving ill-defined problems, problem shaping, goal and constraint management, ideation, thinking through drawing and intuitive reasoning [6]. Designers typically solve ill-defined problems by changing the scope of the problem, the goals or the constraints, even when these strategies are not appropriate. Cross describes how designers typically understand ill-defined problems in relation to solutions. They employ solutions-based thinking that starts with the end-goal, rather than starting with the problem. Alternative solutions are used to explore and understand the problem at hand. Designers tend to experiment early on and quickly change the goals and constraints of the problem.

Cross also identifies that designers appear to express their ideas graphically, through sketching [6]. Space, form and color are the main tools used to explore the problem at hand, and communicate ideas and solutions. In addition to these commonalities, there appears to be common characteristics that are shared by designers in terms of the way they think.

3.1.2 Who Are Designers

The individual designing is called the designer. The adjective 'designer' however, further complicates matters. Many people who are not professional designers may refer to their designerly activities as 'design' work. For instance, people who decide how to arrange things in their homes or are hobbyists in creating their own appearances may call themselves designers. Many domestic jobs can be seen as consisting of designer-like activities. However, in our research, 'designer' refers to the professional activity of designing. These designers make their livelihoods by creating things for consumers. Just like physical skills, such as dancing or swimming, designing could also be viewed as a proficiency or skill. In our case, this skill is something in which people earn their livelihoods.

In our research, we encountered designers with various specialties. Design researchers identified the needs, motivations and behaviors of users. Visual designers created aesthetically pleasing experiences. Interaction designers designed systems that are easy to use. Industrial designers created physical experiences. Each role presented its own challenges in terms of issues of sustainability. Here, we give a brief outline of each role encountered in our research. We explain what each role is accountable for.

3.1.2.1 Visual Design

This field is considered a subset of the graphics arts field, sometimes entitled 'graphic design'. These designers communicate through imagery, words and other visual representations. They are highly focused on the aesthetics of a system. These designers are typically responsible for designing digital interfaces of technology products, in an environment referred to as Graphical User Interface (GUI). This involves considering end-user interactivity on a touch screen or through an input device such as a mouse, trackpad or pen input.

Visual designers often work hand-in-hand with software developers and engineers. Designers specify what the interface should look like, while the engineers build the interface. The main tool these designers use is Adobe Photoshop[1] - a raster-layout program for editing imagery. They also use Adobe Illustrator – a vector-based tool for drawing and sometimes Adobe InDesign, a page layout tool. These tools are sometimes referred to in our study. The titles of these roles are creative or art director, animator, visual or motion designer, or a production artist.

3.1.2.2 Interaction Design

Like a visual designer, the interaction designer also defines the user experiences of a system. Once the interaction designer has a good understanding of user needs, motivations and goals, the designer will sketch interfaces that meet their user's needs. Some designers will sketch on paper. Others will use professional software applications. Despite the tool they use, the end result is a vision of how the system should work. In digital products, the typical output is a wireframe specification of button placements, layouts, and navigation structure. The interaction designer may create several options and test with users which option has the most favorable results. The interaction may be responsible for creating the test prototypes of a system, or may work with a software developer to build the system [47].

3.1.2.3 Industrial Design

Similar to visual designers, industrial designers are also concerned with the aesthetics of a system. However, these designers solely look at the physical properties of a system, such as the form and physical function of interfaces. Generally, industrial designers have a very specific role in the design process, and work on a smaller scale of design, rather than interaction designers or visual designers who may work across the entire product portfolio or system.

The field of industrial design can significantly overlap with the discipline of engineering. The main difference is that engineering focus on the functionality of the system, whereas industrial designers primarily focus on the aesthetics of a system. Industrial design can also overlap with physical ergonomics. Ergonomics typically is concerned with human anatomy only, rather than the interaction between humans and objects.

3.1.2.4 User Research

User researchers are typically divided into two camps [32]. The first camp, typically called 'usability analysts', look at how users engage with an existing system. They look at the emotional value of the experience as well as opportunities for improvement. Some of the questions they ask is 'Does the user understand the function of the system, and is it useful to them?', 'Does the user feel they are interacting with the system in the most efficient way possible?', and 'Does the user perceive the system as pleasurable and visually appealing?'. They may make recommendations to interaction, visual or industrial designers on how to improve the users interaction with the system.

[1] More information on Adobe Photoshop can be found at http://www.adobe.com/

The other camp of user researchers do not evaluate existing systems, but rather look at insights and opportunities in various user populations to introduce new solutions that make people's lives better. This camp of researchers typically spend a significant time 'in the field', for instance at people's homes or place of work. They often produce reports on new opportunities that a business may want to investigate, or alternatively, present trends and insights to other designers to get them to think about the future.

3.1.2.5 Engineering Design

Being that our research is within the field of science, it is important to disambiguate the discipline of 'design' from other professions in the sciences, such as mechanical design or engineering design. A visual designer who is developing a new user interface might not understand why an engineer uses the word 'design'. An engineer's work is typically systematic and methodical. A visual designers work is often less precise, and much more unpredictable. The engineer is typically familiar with the problem and requirements from the outset of the project. A visual designer on the other hand, may only start to understand the problem at hand through the design of a solution. Our meaning of the word 'design', thus, refers to those who deal with highly visual work.

3.2 Design Process

In this section, we give the reader a brief background on what is meant by observing the design process in our research. Design methods and processes are words often used interchangeably, however there are some subtle differences between these two words. Design methods are all the tools designers use when they go about designing. Some of these tools may be personas, wireframing, prototyping or mind mapping [32]. The design process is the ways in which these methods are used through a series of actions and events. In our study, our focus is on the design process. Here, we give a brief background on what the design process entails, and touch on some of the methods used.

The design process is a way in which a solution is generated, through a series of events and steps. There is no single one process that defines design [32]. Rather, there are many different processes that govern the way designers go about solving problems. Many of the design processes stem from systems thinking whereby a set of practices are best understood in relation to each other, rather than in isolation. In contrast to reductionism, the process of design causes the designer to examine the relationship and interactions between all elements of a problem.

In design literature, there are two schools of thought when it comes to the design process [25]. The first school of thought has been called *the Rational Model*. This model states that the design process is driven by a planned sequence of events of analysis, development, implementation and evaluation. The designer is in control and projects can be planned in a relatively predictable manner. The juxtaposing school of thought is called *the Action-Centric Model* [25]. This model supposes that emotion and creativity guide designers, rather than concrete plans. The model theorizes that the design process is largely unplanned and improvised. Designers 'think on their feet', rather than plan out exactly how a system will be created. This school of thought is consistent with the agile approach in engineering.

In reality, designers operate somewhere in-between those schools of thought. Designers may alternate between planned and unplanned activities. They may be informed by new insights that shift the direction of the system, or they may stick to insights recognized at the start of the project. Regardless, it can be said that the designers follow a particular journey. Although the journey may be less rigid than an engineer's process for example, it is more structured than an artist's. Let's look at what a generic process may look like.

3.2.1 Hear Stage

In general, the design process can be broken down into three main stages; **hear, build and deliver** [22]. The **hear stage** involves collecting data from users. Designers typically conduct field research to develop empathy for their users. Qualitative research methods are used to uncover deep wants, desires and aspirations. Once insights are generated, designers may go back to users during this stage to confirm their hypotheses.

3.2.2 Build Stage

The **build stage** translates what was heard during the Hear stage, into ideas, opportunities and prototypes. This stage typically involves brainstorming hundreds of ideas, in order to come up with a couple of truly inspiring ideas. From there, prototypes are built, that are low-cost, to help test the ideas. Creating as many prototypes as possible allows designers to get as much feedback from their users as possible. During this stage, designers move from abstract ideas to concrete solutions.

3.2.3 Deliver Stage

Finally, the **deliver stage** takes all the desirable prototypes, and looks at the technical, and sometimes financial feasibility, for building the desired solution. The activities here, are meant to compliment the work of engineers and computer scientists. Designers may also be responsible for helping to plan the implementation of the solution as well as the launch phase. After the system has been built, designers may continue to evaluate it and suggest future improvements.

Although this process can vary quite drastically from designer to designer, these three stages usually form the core of the design journey. Designers may only work within a particular phase of the design process or the entire journey. For instance, visual designers may only be involved during the Build and Deliver Stages, while user researchers may be only involved during the Hear stage. Design stages may also overlap, depending on time constraints as well as resourcing.

3.3 Research on Design Process

One of the first studies on professional designers was conducted by Gould *et al* in 1985 [17]. Since then, many studies have been conducted within this space. In this section, we review two empirical studies that look at the cognitive style of designers; controlled lab experiments conducted by Lawson, and a series of interviews conducted by Davies. We outline this existing research as a space in which to situate on our own research.

3.3.1 Lawson Studies

Lawson conducted a study in which students and professional designers and non-designers were asked to solve problems in a controlled lab setting [26]. In one experiment, participants were asked to complete a design using colored wooden blocks on a computer. Some rules were given to the participants on how they can and cannot combine blocks. However, similar to real-world design problems, there were also some hidden rules governing the link between blocks that were only revealed as participants were attempting solutions. Unbeknownst to the participants, the computer recorded the participants' problem solving strategies throughout the study.

An interesting difference existed between non-designers and designers. Non-designers tried out a series of designs that used as many combinations as possible. They typically tried to try and figure out the rules of the problem as fast as possible. By contrast, designers did not attempt to discover the rules. Rather, they selected blocks based on the initial rules. If the blocks were not an acceptable combination, then another block combination would be tried until there was an acceptable combination. The essential difference between non-designers and designers, in this study, was that non-designers focused their attention on understanding the rules of the problem whereas designers were obsessed with achieving one single desired combination.

Lawson quickly discovered that the problem-solving styles between designers and non-designers were different. Non-designers employed a problem-focused strategy, while the designers were described as solutions-focused. Both of these groups came up with good solutions, however they both solved problems differently. Lawson credited the difference due to education that makes designers and non-designers think differently, rather than an innate cognitive style.

Lawson was the first to make a distinction between the scientific method and design thinking. The scientific method typically starts with well-defined parameters. These parameters are used to solve a problem. However, the designerly way of solving problems typically begins with a solution. The solution is then iterated on to explore the problem space. Design thinking recognizes the complicated relationship between the problem and solution. Often, the problem and solution are intertwined.

The major criticism of experimental studies was that they do not model real-life scenarios, and do not take into consideration the everyday realities of the design profession. Thus, a different research method was chosen to look at designers. Interview studies were conducted in the designers' place of work, which allowed us to observe how designers work under regular conditions.

3.3.2 Davies Studies

Davies' interviews also seem to reflect many of the same findings from Lawson's stream of research [7]. Drawing and sketching seemed to be very important to the practice. The design process seems to rely heavily on sketching to communicate ideas to fellow collaborators. Designers tended to see their work as a journey of exploration through each drawing, as concepts developed. Davies also confirmed the view that design consisted of exploring solutions often before a problem was fully

defined. What the designer needed to know about the problem only reveals itself once they are starting to solve it.

In interview studies of acclaimed designers, researchers identified personality characteristics that seem to be making designers successful. The most prevalent characteristic was a high awareness to internal and external environments. The designers interviewed all seemed to be sensitive to nuances in their experiences, in which their counterparts were not sensitive to. These designers were able to recognize opportunities, often turning bad events into opportunities. According to Davies, it seemed that events were often construed in a positive light by designers. Designers overall, tended to be optimistic.

A related study identified two unique traits in designers, in terms of how they solve problems [33]. The first trait is empathy. Design thinking looks at problems with a deep empathy for those affected. This is similar to the characteristic of user-centered design explained in the previous section. Secondly, creativity and creative thinking seem to be employed throughout the design process. A large body of literature has examined this type of creativity, not just in design studies but also in psychology and philosophy [6]. It is generally thought that individuals can become better at solving problems and producing desirable solutions if they adopt the characteristics of a design thinker.

3.4 Summary

This chapter introduced the reader to the profession of design. A definition for design and designer was established. We identified the many aspects to a designer's job such as solving ill-defined problems, problem shaping, goal and constraint management, ideation, thinking through drawing and intuitive reasoning. We also outlined the various roles and responsibilities that designers take on in various specialties. All these specialties were encountered in our research. We also specified the three stages of a typical design process: hear, build and deliver. This helped familiarize the reader with the space in which the research is conducted. We also reviewed existing research on designers.

4 Study

In order to understand the design practices of technology designers, we chose to employ qualitative research methods in our study. The purpose of our study was to look at how the practices of environmentally minded designers differ from traditional designers. To get a full picture of these differing practices, we wanted to collect as much information as possible about these designers' practices. We sought to learn about what designers are creating, how they are creating things, what tools or methods they are using, and as many details as possible about the roles they play in an organizational context. As described in Chapter 1, qualitative methods were best suited for capturing the full range of information required for this study. The qualitative method selected was one-on-one interviews. By interviewing designers, we can obtain a level of detail that is rich in personal insights.

This chapter begins with reaffirming the objectives of the study, as well as restating the specific questions the study aims to answer. The process of data collection is described in detail. The chapter then concludes with a description of how the data was analyzed.

4.1 Objectives

The goal of the study was to describe the practices of environmentally minded technology designers in the field of mobile communications, and compare the practices to those of traditional designers. In comparing these practices, we discovered how environmentally minded designers employ their problem-solving skills differently than traditional designers. To characterize these differences, we sought to learn about what designers do, how they think, and as many details as possible about how they go about designing an artifact. Another goal of the study was to determine what motivates designers to design with the perspective of sustainability. Specifically, we wanted to understand why some designers formed a deep commitment to sustainability, while others did not form this commitment.

It is important to note that we were not interested in examining every single difference between environmentally minded and traditional designers were reported on. The design process is very complex and multifaceted. Hence, we chose to focus on reporting and analyzing only certain areas of interest. Our main interest was the series of actions and events in which a product, service or idea is created, ie. the design process. Although much data was collected about the methods and tools used during the design process (ie. affinity diagrams, technical drawing software) we were less concerned about looking at the differences between designers in terms of their supporting tools.

4.2 Sample

A total of 22 designers were interviewed from the disciplines of user experience design, industrial design, visual design, interaction design and user research. Eleven participants were part of the same design team. The other eleven participants were situated in design roles across the company. Some of the teams they were on included software development, research, prototyping and engineering. Environmentally minded designers spanned across all these different teams. All designers were responsible for shipping various experiences, or portions of a particular software or hardware experience. The roles in which these designers served all required well-developed awareness of the designer's procedures used either broadly across the organization or in particular depth with respect to a specific design project.

In this thesis, designers are identified with the label 'D' for designer (D1-D10), or 'G' for green designer (G1-12). Participants labeled as environmentally minded or green were required to design or co-design a technology product, feature or initiative that aimed to improve the social, economic or environmental welfare for their users. In four out of the twelve roles, the word 'sustainable' or 'sustainability' was explicit in their job title or job description. The other 8 green designers self-identified as green, typically because they worked on environmental initiatives at their place of work.

Green designers were hired by the mobile phone manufacturer initially, to help comply with legislations such as the Waste Electrical and Electronic Equipment (WEEE), Restriction on Hazardous Substances (RoHS) and Registration, Evaluation, Authorization and Restriction of Chemical substances (REACH). These designers main responsibility was to ensure that the products produced by the mobile phone manufacturer could be be shipped and sold in countries with strict electronic legislations.

In addition to the main responsibility of compliance, designers were often involved in lifecycle analysis to help the company reduce costs of shipping products. The designers looked at various efficiency gains at different stages of the product lifecycle. Some of the considerations include:

- Minimizing resource consumption
- Use of lower impact, non-toxic materials
- Use of durable materials that result in less frequently replaced products
- Energy efficiency during the manufacturing process and in-use
- Design for re-use or recycling

Green designers also took it upon themselves to try and extend the life of products in various ways. Some examples of extending the life were:

1. **Industrial defects to achieve product differentiation**
   Purposefully discoloring, streaking and bowing products, promotes the value of individual distinction, which may delay the discarding of the object.

2. **Evolution during the aging of a product**
   Design products that gradually improve over time, almost as though they are reacting as living entities sharing the experiences of users.

3. **Design for disassembly**
   Once the products break, allow it to be repaired.

4. **Design for secondary functions**
   Once the product cannot be used for its primary function, allow it to have other functions.

Some designers were also involved with helping to change the business model from a product-oriented model to a service oriented model. The service model may offer a more dematerialized solution than before, and thus has the potential to encourage low consumption patterns of sustainability. The green designers were involved in three areas:

1. **Services providing added value to the product lifecycle**
   Here, the designer is responsible to the customer when the product can no longer be used for its primary function. This approach often minimizes waste, and focuses on a model of maintenance, repair, upgrading and substitution. Here, the designer tended to be involved with take-back programs and new maintenance contract programs.

2. **Services providing final results to customers**
   In this approach, the function of the product is sold to customers rather than the product itself. The business retains ownership of the product and gets paid for providing the agreed results. This often reduces the amount of components a company has to produce, as well as extends the material life of the product through re-using and re-manufacturing. The designer here was involved in the design of these new functions.

3. **Services providing platforms to customers**
   In this approach, the designer was involved in producing services for the customer. Examples in other industries of this model are laundry services, car sharing and tool rentals. The advantage for the environment here is that fewer products are needed and the life of a product is often extended.

4.3 Method

To understand the difference in practices between environmentally minded designers and traditional designers, the interviews were conducted in a natural setting. Although the least logistically practical, it was imperative that the interview took place in-person. Seeing how the designers acted and behaved served as data points throughout the study. The natural setting consisted of interviewing the designers at their place of work. The environment would prompt the designer to recount details that otherwise may have not been apparent if the interview took place outside their place of work. Participants often reached for supporting artifacts, such as briefs, project prototypes, etc. We

included these as secondary data points in the study. All participants were interviewed individually. There was no payment for participation.

Because the study involved human participants, it was reviewed and approved by the Office of Research Ethics at the University of Waterloo. Consent to conduct the study was obtained from the business gatekeepers of a large, mobile communications manufacturer. A consent form was also sent to the interviewees asking if they agreed to participate in the study, whether they consented to audio recordings of the interviews, and whether they would allow anonymized quotations of themselves to be used in publications. The consent options were presented separately, so interviewees could take part in the study without consenting to audio recordings or use of quotations in publications. The letter to the business gatekeeper as well as information-consent letter is reproduced in Appendix B.

Participants were recruited through a distribution list sent to various design communities at the technology company. The recruitment letter is reproduced in Appendix B. Those who expressed interested in the study were vetted by the researcher, to make sure they qualified as a 'professional designer'. A prospective participant qualified for the study if they were part of the following teams: visual design, interaction design, user research, industrial design, product management or design management, and were responsible for designing technology products, systems or services.

The participants underwent three rounds of interviews. Handwritten notes were taken during the interview, as well as audio recordings. Each round was semi-structured. The researcher had broad questions and themes to ask each participant, however, the interviewers were mostly open-ended, unscripted and followed the participants' responses. The interviews were approximately 45 to 60 minutes. The first round of interview began generally, with the following questions:

- Tell me about yourself, your role at this company, etc. (warm-up questions)
- Describe to me about your design process. Walk me through how you'd start, develop and end a project.

After establishing a conversation, interviews were focused on design practices, with questions such as:

- What does the word 'sustainability' mean to you?
- Does sustainability relate to your design practice? How so?
- Tell me about a time when you considered environmental factors in your design work.

The second round of interviews asked designers to walk through a current project or two. By asking for walkthroughs on current projects, we gained a deeper understanding of the designers' everyday realities. It is important to note that we were sensitive to the confidential nature of these projects, and hence do not report on the details of any project directly.

As themes emerged from the initial data analysis, a third round of interviews with the environmentally minded designers sought to validate assertions resulting from the analysis:

- Tell me about your commitment to sustainability at home, in your personal life.
- Describe a time when you felt like you just 'didn't know' if your idea or design was going to work out.
- Tell me about you justify the rationale behind your designs, when designing something new and novel.
- Tell me about the various hats you wear in design projects.

When talking to experts in most fields, the passion often lies with what was created, rather than how it was created. Designers were no different. Often, they had to be redirected to explain their thinking process and procedures. Even the most senior designers had a difficult time focusing their conversation on the activities of design, rather than outcomes. To overcome this challenge, our interview was in the style of project walkthroughs, where the designer was asked to walkthrough the conceptualization, development and implementation of particular works of design. Throughout the walkthrough, designers were probed on specific details around their thought processes.

It is important to note that this interview style (project walkthroughs) may not reveal the entire picture [36]. Design researchers have outlined that non-verbal reflections are intrinsic to the act of design, and thus forcing verbalization throughout interviews may interfere with the designer's way of thinking. On many occasions, we did have to probe the designer to think aloud. Hence, we must be careful about drawing any immediate conclusions around the cognitive abilities of green designers. However, we feel there are still many useful observations discovered throughout these interviews.

4.4 Analysis

Grounded Theory method was used for the data analysis [36]. Rather than defining a hypothesis at the beginning of the research, the first step was to collect the data, then from the data, develop codes, categories which form the basis for the creation of a theory or themes. Coding consisted of organizing the data into meaningful segments, assigning names to the segments and then combining them into broader categories and/or themes. The tool used for the data analysis was the affinity diagram. Affinity diagrams are used to sort through sizeable amounts of data. Data points are written on cards. The cards are then added to the diagram. Related cards are grouped together. Cards are continuously added and themes may emerge. By repeating this process for many iterations, a hierarchy of themes and sub-themes emerge with the data points structured beneath them.

The data analysis consisted of the interviewer's notes as well as the audio recordings from the interviews. After analysis of the first round of interviews, we began with a short list of six categories and then expanded the categories as we reviewed more interviews. After the second round of interviews, we developed approximately 30 categories of information that were then combined into four themes. In developing the codes, categories and theories, the following criteria to decide what information should be kept, and what should be discarded:

- Does it offer new, previously undiscovered insights?
- Does it challenge or extend current design practices?

- Does it portray the broadness of the studied experiences?
- Does it offer interpretations that technology designers and makers can use in their everyday lives?

Several issues are important to address in the process of coding. The first is the use of pre-existing codes or themes. We did not use any predetermined themes, but rather allowed the themes to be developed inductively and emerge from the data, rather than imposed on the data. This allowed for all interesting data points to emerge. Second, throughout the analysis we were open to additional codes. On-going interviews were tuned to exploring the preliminary existing codes in greater detail. The interviews were updated with new questions. Additional codes were continuously incorporated into the affinity diagrams, until the final themes emerged. This allowed us to discover new data, perhaps undiscovered by previous researchers.

Grounded Theory method is widely accepted in terms of its academic rigor [20]. Just like other methods however, Grounded Theory does have some drawbacks. First, sometimes the subjectivity of the data leads to difficulties in establishing reliability. During the third round of interviews, our themes were combed with participants to validate assertions resulting from the analysis. This helped confirm our final data points. Due to the human cognitive bias towards confirmation, an active search for disconfirming evidence was essential in achieving quality of data. We felt validity was achieved through this approach.

5 The Sustainability Lens

In comparing the practices of environmentally minded designers with traditional designers, an important first question to ask is why do environmentally minded designers commit to the perspective of sustainability at all. In this chapter, we describe how the commitment to sustainability appears to be influenced by three sources: a pro-environmental lifestyle, a transpersonal orientation and acting on behalf of users.

We then describe how these sources of commitment appear to influence the design process. Designers who are environmentally minded appear to overcome novelty of the product they are working on, have a clearer sense of priorities that makes the design process less diverging, and sometimes use a lens of human rights to look at design work. In contrast, traditional designers in our study prefer novelty, must deal with more tensions throughout the design process as well as use the narrower lens of accessibility to look at design projects.

5.1 Sources of Commitment

Respondents were asked to describe why they committed to a sustainability perspective in their professional lives. Their answers revealed three main motivations; (1) these designers tended to follow a pro-environmental lifestyle. Naturally, their work was a reflection of this lifestyle. (2) Designers were motivated by a spiritual or religious practice. This motivation is explored in more detail. To explore the sources of commitment to a sustainability perspective, we used the responses of participants to operationalize the concepts of a pro-environmental lifestyle, transpersonal or spiritual orientation and acting on behalf of users. (3) Designers were deeply motivated by their users. The idea of serving their users was so strong, that they felt compelled to address issues of sustainability.

5.1.1 Pro-environmental Lifestyle

During the warm up stage of the first stage of the interviews, designers were asked about their environmental behaviors at home. Are designers conservative in their consumption behaviors? Are there any noticeable differences in lifestyles between green designers and traditional designers? Unsurprisingly, green designers (G1-G12) all reported practicing a number of pro-environmental

behaviors in their personal lives. These included reducing the amount of possessions (G3), being mindful of work-life balance (G6, G7, G9, G12) as well reducing their carbon footprints at home or while travelling. Green designers also discussed how they took concrete actions to drive less, such as taking public transit or bicycling to work.

In contrast, traditional designers (D1-D10) did not typically practice many pro-environmental behaviors at home. Although they were aware of some of the steps they could take to reduce their impacts, in general, they did not intend on taking those steps soon. The table below summarizes some of the differences between the lifestyle choices of traditional and green designers.

Reported behaviors	Number of Traditional Designers	Number of Green Designers
regularly monitors home energy use (heating, cooling, electricity)	4	12 (all)
drive less frequently	1	10
gardens and/or cultivates own food	1	8
reduces amount of possessions	0	1
mindful of work-life balance	0	4
encourages others to conserve	1	9

Table 5.1 - Summary of pro-environmental behaviors reported by designers

5.1.2 Transpersonal Orientation

When asked about their source of commitment to sustainability, some designers cited a transpersonal orientation as a source for their commitment to a sustainability perspective – that is, they were motivated by a source that transcended themselves. In four of the twelve green designers interviewed, "doing good" was described as their life's calling (G3, G5-6, G10). G10 describes this phenomenon:

> *"My calling has always been to improve the lives that this planet contains – whether it be human or other. To me, this is a service that I need to offer. It's something greater than myself (…). And so my design work has been a calling."* Other ways of communicating this transpersonal element were *"making the world a better place" and "serving those less fortunate".*

G3 describes the motivation for his work as 'leaving a mark on the world'.

> *"The design solutions are the mark that I leave (…) And this mark must leave the world in a better place then I found it!" For these designers, their sustainability work is a way for them to observe their own values.*

Two designers reported that their commitment to a sustainability perspective was motivated by a spiritual practice (G2, G7). Their spirituality gave them a strong sense of place, a connection with nature and a feeling of reverence to the physical world. The deep meaning they got from their spirituality was brought to their work as environmentally minded designers. For these designers, it gave them a way to look at design work on a spectrum, instead of categorically. G7 describes how yoga gave her a way to look at sustainability as a spectrum, rather than a duality:

> *"I think I mentioned this, but my yoga work is one of the ways that I engage in the world. (…) So in yoga, there are three moves that I hold dearly; surrendering action to the divine, releasing attachment from things you are or were very committed to, and working as hard as possible. There was a time when I thought everything was black and white, right or wrong. I would think about design and sustainability in terms of that sort of dualism. Then at some point, my sustainability work and my yoga wasn't working together. I was stuck in dualisms. But yoga helped me see beyond dualities, and help me recognize the many."*

5.1.3 Acting on Behalf of Users

Green designers felt a strong motivation to serve their users, and the public. For three participants, it was about "acting on behalf of their users" or humankind.

> *"Users don't know what they want. As a designer, it's my job to suggest the moral path forward (…) And if I offer the best environmental choice possible, I believe most people will choose that one. We just have to start offering better choices to users." (G4)*

In terms of environmental sustainability, green designers recognized that their users were not the best sources of judgment. Green designers often felt they were in a better position to determine what was in the best interest of users and the planet, by limiting the users choices.

> *"Users don't know what they want until they see it, and even then, they may only discover after prolonged usage that in fact, it is not what they wanted because it's bad for the environment." (G10)*

In contrast, traditional designers had the belief that users will know how to choose right from wrong, and most frequently, will choose the pro-environment offering. For green designers, a deep, personal commitment to sustainability was also strongly related to the values of equality and equity. At work, green designers reported providing equal opportunities for all their users, particularly the least fortunate or most vulnerable. This is not that different than the values of social sustainability discussed in Chapter 2.

> *"All my users are treated equal. I don't have favor certain segments over others, even though the business may profit from certain segments over others. I just try to make my designs as useful as possible to everyone who everyone that uses them." (G4).*

In contrast, traditional designers reported intentionally not designing for particular segments of their user base. "*If I designed everything to work well for everyone, I would have no time to advance the business*."

(D2) For the traditional designer, catering to certain users over others was a matter of business priority and focus.

5.2 Influences on Design Process

The commitments in designers' personal lives appeared to have a deep influence on their professional activities. A designer describes how environmental commitment in his personal life affects design decisions at work:

> *"I'm an environmentalist on many different levels. At home, I try to do all the right things (…) At work, I find myself incorporating the simpler, lower-impact lifestyle that I've chosen. (…) Everything that I design at work has been thought of in terms of carbon impacts, not that different than my personal life. Its very important that I stay true to my roots." (G6)*

Unsurprisingly, green designers tended to prioritize environmental concerns over most other factors considered throughout the design process. For instance, it was easy for a green designer to prioritize using a more expensive, environmentally preferred material for a product. G11 discusses how his commitment to sustainability helps him prioritize his design choices, and hypothesizes that other designers would not have made the same pro-environmental design choice.

> *"This (material) was chosen due to its environmental performance. (…) If it was up to a different designer, perhaps the environmental performance wouldn't be a deciding factor. If it was up to the business, it (environmental performance) probably wouldn't be a factor at all. For me, it was the most important thing that guided the material selection phase of the project."*

Similarly, designers describe how their values at home are not separate from the choices they make at work.

> *"It's not that different here (at work, than at home). I try to make things that are not just in the businesses best interest, but also in the best interest of the planet." (G2).*

A green designer describes how his environmental commitment at home, enables him to design with a pro-environmental perspective at work. G3 tended to recycle, monitor his energy usage, and walked or bicycled to work when he could.

> *"I live a, how do you say, frugal lifestyle. I buy only what I need. And I make sure that what I buy will serve me well for a long time to come."*

G3 goes on to describe how this relates to his work.

> *"I practice what I preach. My family and I live a certain way. I'm going to help users do that as well. (…) I don't see my design work as that separate from my personal life."*

5.2.1 Overcoming Novelty

The green designer's transpersonal orientation helped confine their excitement towards the novelty of the technology, and rather give focus on the intent of the application. G4 describes this underlying theme of technological novelty restraint:

> *"For some designers here, it's about the 'tech'. How fast is the processor, how much memory, how many megapixels there are. Just talk to the concept designers here (laughter). For me, it's about creating something that makes lives better."*

G4 goes on to explain how his spiritual practice grounds his design work.

> *"At the beginning (of my career), I definitely overvalued what the technology could do. Yes, it's amazing to see how far the technology has come. But we're at a point where we don't even need to know how something works. I just need to figure out what it should do. (…) So now, I guess you can say I'm less of a technologist and more of a designer."*

In contrast, when talking to traditional designers, it appeared that the novelty of the technology generated an increased interest in design projects. In particular, one traditional designer enjoyed working with the 'latest and greatest' technology, even when the designer stated there would be no practical application. This novelty effect would seem to diminish after the designer became more familiar with project. Similarly, another traditional designer described how he prefers working on conceptual design projects because he gets to "*play with the latest tech*" (D1).

The designers' spiritual practices gave a daily structure to reflect on their work.

> *"It (religion) brings daily routines. Five times a day, I'm forced to reflect on my contributions. (…) In terms of my office work, this helps me put things in perspective."*

The designer further elaborates on how his spirituality forces him to release personal attachment from the work, and think about his work on a removed level.

> *"I sometimes feel like I'm designing in a completely different world. (…) The level of consciousness I get from my daily spiritual habits helps me think about my work and my users as human beings, rather than simply users. Many other designers don't get that, especially the ones that aren't working in the area of sustainability."*

In contrast, traditional designers did not typically report having a structured way to reflect on their design, and the bigger picture. Nor did they report on routinely reflecting on their work, in terms of how it's benefiting the world.

Spiritual practices and transpersonal beliefs about '*doing good'* helped these designers engage with their work. These beliefs also helped confine their excitement about the novelty of the technology, and eased their ability to focus on user needs. In contrast, traditional designers did not report a

transpersonal orientation. Almost in direct contrast, some traditional designers only wanted to work with novel technologies.

5.2.2 Less Divergence

Prioritizing environmental values appeared to make the design process less diverging. A green designer reports how committing to a sustainability perspective makes it easier to make design decisions.

> *"Design is always about tradeoffs. However, when you're willing not to compromise because of the environment, then it makes making decisions easier." (G7)*

For this designer, environmental concerns took precedent over everything else, even if was at odds with business needs.

> *"If there's a higher cost (in making an environmentally preferred product), that's management's job to figure out how the business is going to afford to make it. (…) If it's healthier for the environment, it means it's better for our customers. Period." (G7)*

Traditional designers felt a greater tension between the needs of business and the requests of green designers. Traditional designers reported frequently mediating between business needs and environmental concerns, constantly balancing the needs of opposing stakeholders. D5 elaborates on this tension.

> *"I'm always in a tough spot. (…) What's best for shareholders is not always what's best for users, and vice-versa."*

D5 goes on to explain a situation whereby he was mediating between a green designer and a manager. The green designer was advocating for a more expensive, environmentally preferred solution to be used in the construction of a product. The traditional designer describes how he was caught in the middle.

> *"It was my job to persuade both sides to come to an agreement. Of course, I always want what's best for users. But at the same time, I'm responsible for finalizing this product so the pressure was on to reach some sort of consensus."*

5.2.3 Wider Design Lens

Traditional designers tended to describe problems in terms of *accessibility*, that is, the degree to which a product or feature is available, whereas green designers described problems in terms of *human rights*. This sharp contrast can be seen clearly in the following quote. A green designer described a situation whereby a product feature was designed for a particular geography of users, disregarding another geography of users of that product:

"It should have been designed not just for the western world, but for everyone who uses the product. (…) Why shouldn't people in other countries be able to benefit from it (the product) in the same way that Westerners do?" (G10)

Traditional designers reported viewing that this design a matter of accessibility. "*It* (the feature) *is not that accessible for these users."* (D3). Accessibility here, means the degree to which a product or feature is available. Because a certain portion product of this feature was not available to all users, the feature was deemed to be '*inaccessible*' by this designer.

In contrast, green designers tended to view design problems through the lens of human rights. In another example, a green designer was discussing how a feature he was working on, required a particularly high physical effort by the user:

"Early on, we discovered that it would be difficult or nearly impossible for certain people (those with physical impairments) to operate the device. We came up with an alternative design for those people. However, because it wasn't a legal requirement or a matter of profitability, the feature never got built. (…) I was upset because, as a matter of ethics and social responsibility, everyone should be able to operate this, regardless of their condition, even if it doesn't make us more profitable as a business."

5.3 Summary

The relationship between a pro-environmental lifestyle and the choices designers make is a complex one. From this research, it is clear that there is a correlation between lifestyle choices and design decisions. However, it is important to note that correlation does not mean causation. We cannot say if designers seek out pro-environmental design choices at work because of their lifestyle choices or if they make changes at home because of their work lives. Likely, it is intertwined relationship between both work and personal life.

This chapter described some of the main inspirations for committing to a sustainability perspective. Environmentally minded designers tended to practice a number of pro-environmental behaviors in their personal lives such as reducing the amount of possessions, being mindful of work-life balance as well reducing their carbon footprints at home or while travelling. In contrast, traditional designers did not report on typically practicing many pro-environmental behaviors at home. Green designers also cited a transpersonal orientation as a source for their commitment to a sustainability perspective – that is, they were motivated by a source that transcended themselves. This seemed to have a deep influence on the work lives.

At work, green designers seemed to prioritize design decisions with ease, compared to traditional designers that cited that business priorities guided their design priorities. The transpersonal orientation of green designers helped confine their excitement around the novelty of the technology. Traditional designers also took a much more stoic view when it came to meeting the needs of all users, whereas green designers reported keeping their ideas grounded and meeting user needs instead of 'wants'. Furthermore, traditional designers often viewed design problems in terms of *accessibility*,

that is, the degree to which a product or feature is available. However, green designers described problems in terms of human rights. It is these differences between environmentally minded designers and traditional designers that is the subject of the remainder of this study.

6 Roles and Relationships

Designing can be a social process, and therefore social interactions, roles and relationships should not be ignored. In the context of technology design, teamwork is considerably important. It has become of even greater importance when dealing with the far ranging issues of sustainability. Understanding how designers operate in an organizational setting is, therefore, imperative to advancing our understanding of environmentally minded designers, and how their roles may differ than traditional designers.

In this chapter, we describe the three roles designers took on throughout design projects – facilitator, supporter and catalyst. The role of facilitator was one shared by all designers. The latter two roles, supporter and catalyst, were roles described only by green designers we interviewed. We describe how green designers fluidly served multiple roles throughout the design process.

6.1 Three Roles

While participants were taking us through their design journeys, it became clear that working in a group setting introduced many challenges and possibilities for designers. In comparison to working alone, designers established particular levels of authority with other members of the team. Some of these roles were formalized, such as Principal Designer or Lead Designer. However, most of the time, the roles were implicit.

We identified and classified these roles into three areas; facilitator, supporter and catalyst. In the next sections, we describe each of these roles and supporting evidence.

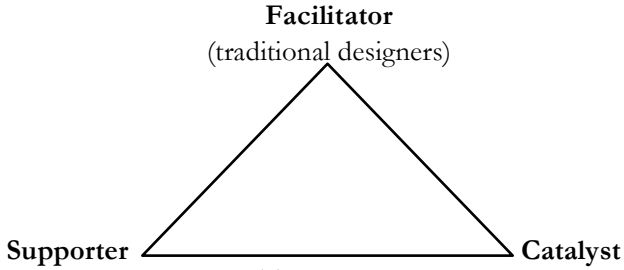

Figure 6.1 - Three roles of designers

6.1.1 Facilitator

The first role was commonly referred to as 'facilitator'. In this role, the designer's responsibility is to help the group of stakeholders understand common goals, and direct them towards a common vision, without necessarily taking a particular stance on any issue. The designer tended to offer 'suggestions' and 'recommendations', rather than precise solutions. This left breathing room for stakeholders to negotiate and talk through solutions on their own.

Both groups of designers reported attending to the varying opinions of management, while 'listening' and reserving judgment. G1 offers an explanation.

> *"I've told them (stakeholders) that it's not a matter of imposing my own ideas, but rather it's about them coming in, listening, talking and engaging with me, and the work. My job is to listen (…) It's very much about 'outreach', and bringing them in. (…) All my judgments can come later."*

For this designer, it was important to bring together different groups and allow them to collaborate in a creative way. This designer described leading a process of dialogue that helped move the project forward. To achieve this type of cooperation, the designer used tools such as concept maps, design exercises, and brainstorming exercises. These tools helped the designer invite people into the dialogue, and allowed for the active participation of non-designers.

G9 offers a similar explanation, where she reserves judgment so that she can facilitate building a shared vision among stakeholders.

> *"I create a safe environment so that anybody can offer their ideas. I try to remain neutral, even though I have strong opinions about which paths to take. (…) I was trying to create a space where we can hear each other's opinions openly and honestly. The trick is to actively manage tensions to let natural inquiry occur. (…) Once we (stakeholders) we're all on the same page, it's much easier to agree on the next step (…). Without that mutual understanding, it would have been harder to agree on a solution."*

In G9's comment, we note the lack of comfort with the facilitator role. Green designers, by nature of their role, have an agenda during the design process which is sometimes at odds with the role of facilitator. However, adopting the role of facilitator allowed green designers to create a trusting environment throughout the design process where other designers and stakeholders could explore the design problems from different perspectives.

Adopting the role of facilitator allowed designers to create a trusting environment throughout the design process where other designers and stakeholders could explore the design problems from different perspectives. G3 explains how this role is important to his work.

> *"I'm trying to create the conditions so that everyone can offer a different view on the problem. (…) I'm aware this is my role at every design review, product management meeting and actually, pretty much, with any conversation."*

This designer contends that his "*real job*" is to be a "facilitator". By doing so, the designer reports supporting the emergence of solutions that need to be identified and the ability of influence design decisions so that they are more environmentally responsible. Similarly, G11 reports how his role is to remove barriers to design problems. He '*holds the space*' and creates the necessary supportive conditions for people to collaborate on design problems. Some of the other phrases designers used to describe this role are: '*tension holders'*, '*mediators*', and '*intermediaries in the design process'*.

G1 offers a final perspective on what it means to be a 'facilitator'.

> *"Before the meeting, I remind myself to take a step back, and think of everyone as co-creators. (…) It's important for the design that everyone gets to voice their opinions. My job (if acting as a facilitator) isn't to take a stance, it's just to facilitate an open dialogue."*

To be a facilitator meant to inspire and engage team members, in understanding design problems and then helping to develop innovative responses to them. In our research, both green and traditional designers reported adopting the role of facilitator.

6.1.2 Supporter

It is inevitable that conflict arises between stakeholders. In our study, there were instances where green designers advocated for an outcome that was in the best interest of users and for the environment, but perhaps not in the best interest of shareholders. Although green designers took an active stance on the issue, in the role of supporter, they eventually consented when a stakeholder came up with an argument that closed the discussion. So to speak, the designer might have 'agreed to disagree', and then moved on.

Nine of the green designers interviewed, described a time where they actively took sides on what solutions would be best for their users. Unlike in the role of facilitator, where designers would perhaps only have an opinion or recommendation, here, designers actively argued for one direction over another. This was not a passive role, but rather one riddled with debate. G4 describes a time when he was in conflict with his peers.

> *"It was much better than the solution product management proposed. However, I knew it cost a bit more to produce, so I had to convey my argument not just in terms of dollars but also user satisfaction. (…) In the end, I lost the argument (…) I just had to abandon the issue altogether and get moving to the next meeting."*

In the role of supporter, designers would report showing the way to a better vision.

> *"I see myself carrying forward a more challenging vision for this (a particular feature). Management needs to recognize how much better this could be. (…) That's what my work is about – pushing for even bigger vision and then helping to build some of that."*

Designers would invite their stakeholders to this '*superior calling'*. "*I held many workshops to get everyone on-board. I knew it would take lots of convincing.*" (G2)

Green designers sometimes followed a process, where they would list out barriers to their work and actively try to remove them – one by one. G3 describes how he removed barriers by directly working through tensions.

> *"I'd like to give the analogy of a masseuse, I believe you call them a massage therapist here. What they do is not that different. They find a point of tension, and push on it as hard as possible, until the tension gets released. What I do is the same thing. I anticipate the pressure points, make sure they get addressed and discuss them thoroughly until everyone is comfortable with ruling out the point. To anticipate these pain points, I usually talk to each of stakeholders before a big meeting like this occurs."*

Because green designers are advocating an approach that can be at odds with the most cost effective or expedient approach to design, this process of anticipating resistance, and of acting as a supporter of a specific decision, was particularly important to them in incorporating their vision into any final design artifact.

Another designer describes a time where she actively countered a stakeholder's suggestion. She explains:

> *"The user report showed it was a bad idea. And he (the stakeholder) still wanted to go ahead with it. So I brought him the report, and show him the reasons why he was wrong." (G7).*

The designer went on to describe how the stakeholder disregarded the data, and G7 had to gather and influence the opinions of many other stakeholders to counter the opinion of this one stakeholder. G7 experienced much difficulty getting to stakeholders to proceed in a way that she preferred. This demonstrates some of the tensions that are evident in green design.

In contrast, traditional designers did not report many conflicts between stakeholders. This could be a coincidence. More likely, it is because the issues that they deal with are less provocative. Traditional designers only needed to play the role of facilitator to advance their cause, whereas green designers needed to take sides on issues.

6.1.3 Catalyst

The third role that green designers adapted to was that of 'catalyst' of progress. All green designers interviewed, designers described actively driving growth of sustainability initiatives through conflict. Words to describe this role were "driver", "owner" and "catalyst". G5 describes this role:

> *"I believe I was the catalyst. (Pointing to a project) I tried to push the boundaries. It was definitely years upon years of struggles before I was able to see the fruits of my labor."*

Another (G11) designer describes his role as catalyst.

> *"Designers are responsible for creating great user experiences. Some of us take on much more than that. [referring specifically to green design] (…) Lately, I've driven (environmental) projects from start to end. I don't mind this responsibility, but it does take a lot out of you."*

Other designers described themselves as '*pushing and shifting boundaries'*. G12 contends that his "real job" is to "*make people uncomfortable, especially managers*." By doing so, this designer seems to only answer to the needs of his users.

> *"We've got many people saying this is impossible to achieve (from an environmental perspective). 'This was tried before, and it didn't work.' As a designer, you have hold down the fort, and question why it's impossible. From there, you get answers on what is possible. (…) In a lot of cases, what we thought couldn't be done was indeed possible."*

All green designers reported taking on the role as 'catalyst' at one time or another while it was uncommon for traditional designers to take on this role. Green designers reported quite frequently evangelizing various teams in support of sustainability projects. Rather than directly engaging with these teams, as in the role of 'supporter', this role was much more active and sometimes controversial. This is evidenced by some of the phrases the green designers used like 'pushed', 'drove' and 'exposed '.

In a sense, green designers often took on a more adversarial role than traditional designers. One describes the role of 'catalyst' as a balance between pushing on people's boundaries, while not dissuading them for the project at hand.

> *"It's a fine balance between pushing people to edge, asking them to grow, as well as not making them feel like they are being personally attacked." (G8)*

G4 explains the role of 'catalyst' quite clearly.

> *"I guess you can say I'm a mover and shaker. A lot of people may not like me or my ideas, but what I build wins out every time with users."*

This participant also suggests that these roles may overlap or also be concurrent.

> *"I wear many hats. I know when to push, but also know when to pull back and just listen."*

Green designers tended to be more aware of the natural tendency to have cohesive views in a group setting. This awareness gave comfort to designers when their beliefs differed.

> *"It's easy to second guess yourself, when everyone has a different interest (in the project). (…) You have to remind yourself that you're always going to be the outsider. But that you have a lot of value to add to the project."*

In contrast, traditional designers never discussed how their opinions get influenced or change in a group setting. We discuss this contrast further in the Discussion.

6.2 Serving Multiple Roles

In this research, we have seen how green designers sometimes play the role of advocate. Green designers also reported frequently switching between advocacy roles, simultaneously. Designers would describe situations where they would be facilitating the exploration of a design problem, and during the project, they'd move into an activist role. After consensus or a decision was reached, then they would switch back into the role of facilitator.

The most frequently reported transition was from facilitator to either supporter or catalyst, then back to facilitator. Throughout the interviews, eight of the twelve green designers interviewed, reported such a transition. G2 recounts this transition:

> *"Yes, my role in the project was to help reach consensus so that we could start actually building it (a feature). At the last meeting though, I strongly disagreed with the direction being proposed and hopefully made some very convincing arguments of my own. After I said my piece, I went back to hearing everyone's ideas about other design challenges."*

G11 describes the fluidity between switching roles. He describes time with his manager, where in the same design review, he switched from his role as facilitator to catalyst, then back to facilitator. After acting as a catalyst, he was quickly able to resume his role as facilitator, after what seemed to be a heated discussion.

> *"It was give and take. He (his manager) openly told me his ideas. (…) I listened and took notes. But when it came to… (a specific feature) (…) I was not willing to bargain. (…) After that intense moment in the review, I just went back and recorded the rest of his ideas, and gave some feedback on what I thought. (…) Even though I was a bit red in the face, I just acted like a regular designer again."*

After probing further on the notion of 'coming and out of being a regular designer', G11 elaborated:

> *"During reviews, I try to keep everyone on point and give my suggestions from time to time. (…) Here though, I was not willing to compromise, so I had to switch gears and stand up. (…) People need to realize I have years and years of experience with this. I have a good sense of what's going to work, and what won't."*

Green designers seemed to discuss this transition in a positive light. Understandably, having an opposing view may be difficult, however all green designers seemed to view this as a necessary and important part of their job. By switching back and forth between roles, designers seemed to be better able to stay true to their design intent as a green designer.

The phenomena of switching back and forth between roles seems to go against existing design research that suggests as designers learn to work in a new team, their controversial opinions tend to regress [25]. This allows the group to design and collaborate with more ease. In contrast, in our study, as reported by green designers, opposing views do not regress even after working with the same group for a long time. In some cases, opposing behaviors are strengthened. For this designer, getting to know the group was a stimulus for being confident in his approach. A designer explains this:

> *"No, I find as I get comfortable with the project team, I'm freer to voice my opinions. (…) Not because they want to hear it (the opposing views) or anything, but because I'm more at ease with the new group." (G2)*

6.3 Summary

In this chapter, we described the three roles designers played in a group setting – facilitator, supporter and catalyst. The first role was commonly referred to as 'facilitator'. The designer's role here was to direct the project team towards a common vision, without taking a particular stance. Green designers, by nature of their role, had an agenda during the design process that sometimes was at odds with the role of facilitator. However, adopting the role of facilitator allowed green designers to create a trusting environment throughout the design process where other designers and stakeholders could explore the design problems from different perspectives.

The role of supporter and catalyst was exclusively reported by green designers. In the role of supporter, green designers actively took sides on what solutions would be best for their users and the environment. Unlike in the role of facilitator, where designers would perhaps only have an opinion or recommendation, here, designers actively argued for one direction over another. In the role of supporter, green designers described actively driving growth of sustainability initiatives. In the role of catalyst, designers took this one growth further by actively driving conflict. Other words to describe this role were "driver" and project "owner".

All of these roles are in some way dependent upon the concept of a team, where designers managed the expectations of all involved. Green designers fluidly served multiple roles throughout the design process. This went against existing design research that suggests as designers learn to work in a new team, controversial opinions tend to regress in a group setting [25]. Green designers seemed to be more aware of the natural tendency to have cohesive views in a group setting.

7 Intuition & Uncertainty in Design

Design literature has written about intuition and uncertainty in the design process [6]. Intuition is 'channeled' by designers to make quick and reasoned decisions. Uncertainty is used to explore opportunities for discussion and critiquing. It is well argued that intuition and uncertainty are critical to the activity of design and help promote ideas around design development [6]. However, the designer's comfort in trusting their intuition and their own uncertainty has not been explored.

In this chapter, we describe the comfort green designer's have in relying on their intuition and being uncertain. In contrast, traditional designers do not have a similar openness. We describe how green designers tend to rely on unusual ways of knowing, other than analytical deduction. Then we dive deeper into the comfort they have established with intuition and uncertainty.

7.1 Intuition and Unusual Ways of Knowing

Green designers described relying on ways of knowing other than analytical deduction. 'Channeling instincts' and 'gut' were some of the words that described how participants accessed sources of knowledge as well as 'unconsciousness', 'intuition', and 'inner-self'. Five participants reported that 'following intuition' allowed them to produce 'superior' work. G8 describes this phenomenon.

> *"It's a shift in my state of thinking, where I try to believe that I know the answer. I'm the creator of the design. I have to empower myself to think so. (…) I think the design becomes stronger because of it."*

G4 similarly reports how 'inner knowledge' supports the design process.

> *"I believe everyone has, what I call 'preternatural' knowledge. This is buried inside, often hard to get to. (…) A lot of good designers are able to channel this knowledge to help them in their design work."*

G4 goes on to give an example of when this knowledge was accessed.

> *"I was drawing for almost 4 hours straight. I don't know exactly what overcame me, but I just had an immense flow of ideas that stemmed from deep inside of me. (…) I just put the design intention out there, got into the right frame of mind, and drew. (…) I was in a heightened state of consciousness where I unpacked everything inside of me."*

Green designers reported that it was ok for their designs to be drawn from personal experiences. They also reported a comfort in drawing from innate beliefs. Traditional designers, on the other hand, felt like they needed to articulate more concrete data about where there design came from. "*All my decisions are grounded in user data.*" (D4) Contrast this with the response from a green designer, "*I go by my gut a lot. I have a lot of years of experience in this field. By now, I have a good sense of what works and won't work.*" (G5).

A designer describes how this 'inner knowledge' is accessed.

> *"I go into a space where I am relaxed. I often need 15 minutes, sometimes a half hour, to get there. (…) From that point on, you can give me anything to design and I'll come up with a better solution than if I didn't spend time relaxing beforehand." G9 explains how she does things with her body to put her in a state to channel 'intuition'. "I relax my shoulders, sit upright and then manifest the energy around me. (…) It's a state where I let everything come out through my hand, onto the paper in front of me. (…) If you were to ask an artist what they experience, I think it would be similar."*

A designer describes the paradox with relying on intuition.

> *"You are surrendering control (to the design process). You cannot think that you're in control because when you're not, and especially when you're not, the resulting design will suffer. (…) So it's a very contradictory process where you're giving up control, but at the same time, empowering yourself to believe that can find the solution."*

At times, designers joined with other designers to create a space where 'intuition' could collectively be accessed. Consider how G3 troubleshoots a problem with her colleague.

> *"We were both thinking along the same terms. I had one part of the solution figured out, (named omitted) had another part figured out. And then it was like the answer manifested itself, right in front of us, at the same time. (…) You just have to trust that it (the solution) will emerge, especially when you're working with someone that you're completely in sync with."*

G1 offers a similar explanation where collectively accessing 'instincts' supported his design process. "

> *We were never one step ahead of each other. In fact, we were able to finish each other's sentences to the point even where we knew what one another was thinking."*

At other times, designers accessed 'intuition' alone.

> *"It's very spontaneous and instinctive work, so sometimes I prefer to work alone. When you're in a group setting, people may ask you 'why this', or 'why that'. You don't want to be stopped in the middle of your thoughts and be questioned. That will ruin your train of thought. (…) When you're alone, you don't have to defend ideas. Instead you can just let it all come out."*

In addition to accessing unusual ways of knowing alone, G2 also explained how he skipped the conventional phases of the design process, such as user research. Typically, some user research is conducted before the design phase begins to get a better grasp of the problem at hand [2]. Instead, this designer purposely omitted this design phase so that his ideas wouldn't be influenced.

> *"Because I feel in touch with myself, my preferences, my needs and wants, I knew that if I designed for what I want, regular people like me, would want something similar. (…) I think going through the user research would have watered down my ideas, or put me on a different course that may not have been right. I'm glad I went with my instincts."*

Interestingly, despite sometimes ignoring user research, green designers in this study acknowledged the importance of involving non-designers to make environmentally preferred products. Nine designers noted that the systems they design are better when they involved collaborating with other departments. G3 explains how assembling a multi-disciplinary team helped create an improved product.

> *"The approach was unconventional, assembling a team from all disciplines. (…) Project teams are increasingly looking more and more like this. Engineers mixed with Sales. Sales with technical writers…"*

One green designer, G8, was interested in interviewing homeless individuals to learn how to do more with less. G8 describes how he felt a homeless man could bring a different perspective to his work:

> *"I tried to bring a homeless man into our studio for a week, to get his perspectives on a couple of projects. He would have had some very unique experiences, that I think, would have offered a fresh look on some the things we were looking at (…) Unfortunately, we couldn't bring him on-site in the end. In general though, we try to form dialogues with the public that are as diverse as the products we design and build."*

Another designer describes how end-users were invited into the design process.

> *"They (end-users) give us some of the best ideas. Rather than treating them (users) like passive receivers, we treat them like part of the design team."*

This designer went on to explain how they now design with end-users in their studio. "*We are now designing with users, rather than for them. It's a really different approach*." Implicit in this approach is the ability for designers to think about outcomes as products of diverse systems.

7.2 Comfort in Uncertainty

Design literature has written about uncertainty in the design process [6]. Uncertainty is used to explore opportunities for discussion and critiquing. It is well argued that uncertainty is an important design activity that helps promote ideas around design development. However, the designer's role in being comfortable with uncertainty, has not been as explored.

Nine of the green designers acknowledged 'uncertainty' as a significant part of the design process. G4 offers a phenomenological explanation:

> *"I hold a huge respect for the power of 'not knowing'. It's ok to not know things right away in these types of projects (sustainability initiatives). (…) I'm often humbled when I see designers in the same situation as me, giving up serenity to the design process."*

Another designer explains what uncertainty means to his design process.

> *"Uncertainty means not knowing what solution is best. Of course, you can reduce the amount of uncertainty. But you have to remember not to be rigid and inflexible. (…) I think many sustainability practitioners understand and respect the feeling for ambiguity."*

G3 reports acknowledging uncertainty through most of the design process.

> *"I relinquish all control, and realize the design is larger than myself. It takes on a form that I don't recognize and I just have to have the confidence to keep shaping it."*

In contrast, traditional designers did not have a similar openness to uncertainty. Very rarely did traditional designers express to management that they were 'uncertain'. If they were 'uncertain', they felt like they were regarded as less of an expert in their domain.

> *"I wasn't sure if it (a particular design solution) was going to work (…) but I still presented the concept as a path the business should take. (…) I'm under constant pressure to know what's best. If I don't know something, my job is to find out fast." (D3)*

Contrast this response with the green designer.

> *"Actually, many times I've come to meetings unsure of the correct way to proceed. (…) You just have to believe that management will be patient with your process." (G4).*

Uncertainty often has a negative connotation. The response to something unknown is to apply an action with the purpose of resolving that state. However, acknowledging uncertainty seems to offer something valuable and quite positive to these green designers. As solutions are explored through design tools such as sketching and paper prototyping, 'not knowing' seemed to facilitate the exploration of ill-defined problems.

> *"I'm comfortable with not knowing right away, what the solution should be. I'm certain in my abilities, and that's all that matters." (G3)*

Being comfortable with their relationship to 'not knowing', seems to allow green designers greater flexibility in exploring ideas and developing a course of action. Traditional designers felt like they were required to justify their work whereas green designers often justified their number of years experience as reason alone enough to trust their recommendations. The traditional designer elaborates:

"I'm required to explain how I came to that idea. My responses tend to be analytical, otherwise I risk being 'shot down'." (D1).

Contrast this with a green designer's comment:

"I often get the question from upper management, 'How do you know?'. I'm comfortable saying, 'Listen, based on my 20 years of experience listening and understanding users, I think this is a better decision." (G8)

There is a unique relationship between the design process and uncertainty, especially because to design is to engage with an idea that has not been explored. In the context of discovery, cognitive psychology supports the notion that 'not knowing' may enhance analytical thinking [5]. Allowing oneself to wander into the moment, rest the tensions of 'not knowing', and allow ideas to emerge allows creators to discover what the system may need.

The different comfort levels with 'uncertainty' extended to the objective of design itself, not just the design process. Traditional designers seemed to be less inclined to engage in situations where they 'didn't know' where they were going. It seemed traditional designers took an approach that was more suited to activities where the objective of the design activity was more known. Green designers on the other hand, were much more involved in design activities that were unchartered. This is perhaps unsurprising as the area of sustainable interaction design is perhaps more novel than other areas.

Alongside a comfort with 'uncertainty' and 'not knowing', some green designers suggest that there may be negative consequences to 'knowing'. G2 explains how 'knowing' is an external construct that undermines work in the area of sustainability.

"I tell most of the designers in this area (those who work on matters of sustainability), that thinking about your design through the perspective of sustainability is very complex. You can't possibly know what the right path is, especially not right away. You have to embrace that the uncertainty you have, will become certainty somewhere down the line. (…) You have to remind yourself of this all the time (…) If you think you know the solution right away, guess again. It's probably premature."

In the face of uncertainty, participants reported seeking the support of their peers. This support often came in the form of encouragement. G7 reports how her network of designers supported her work.

"At this point (in the project), I started questioning myself and my abilities. To be honest, I had no clue how to proceed. (…) So I went to my fellow designers, and largely what they told me was, Ok (name omitted), 'you can do this'. (…) Having the confidence to attack a problem is very important."

An underlying theme was that of trust. Seven of the twelve green designers reported a deep confidence in themselves, their peers and/or the design process. G10 explains this sense of trust.

"I treat my peers with a lot of respect. When we're working together, I truly believe that the solution will be answered between us. What I mean is, I know the solution exists in the room that we're working in. I may need to facilitate the discussion, to provoke questions or reframe problems, but my entire assumption is that these are the right people to figure this out. (…) You just have to have faith in the design process itself."

Another participant describes his torment with self-trust.

"I really didn't know if this (feature) was going to work. I spent almost 3 months not knowing actually. It was agonizing. But I just repeated to myself, that I have to have faith. This is how designing works."

Summarizing 'uncertainty' within design, green designers did not require a resolution or answer if one was not present, either during design or as an objective of design. Rather, they were comfortable with patience in the design process, as well as confidence in the design process. In contrast, traditional designers reported less confidence in the design process.

Consider the response of D8.

"Do you mean, do I trust the process of design so much that it will reveal the solutions for me? No, not at all. It's up to me to push through the design and come up with something brilliant (laughter)."

Similarly, D3 explains how she is confident in her intellectual analysis, not the design process itself.

"The (design) process is all about iterations. As you iterate, you get better and better solutions (…). It's my know-how and abilities that I trust. (…) It (the design process) can really work for or against you." (D3)

7.3 Limiting Intuition

In talking to environmentally minded designers, two designers reported following a more structured approaches to sustainable design. They used lifecycle assessment tools to help evaluate the environmental impacts of a system. Here, designers compiled an inventory of all the inputs used during the manufacturing process as well as usage. Then, they evaluated all impacts associated with the inputs to make more informed design decisions. An overarching principle of efficiency is considered across manufacturing and disposal stage of product consumption.

The supposed advantage, as stated by the designers, is that a lifecycle view provides a systematic way of analyzing environmental impacts at each stage of the lifecycle. Although this allows designers who have little knowledge about environmental impacts to form opinions based on set criteria, it also has the reverse effect of limiting intuition and creativity in the design process.

"Managers have to realize that an LCA (lifecycle assessment) is just one more tool to use. (…) You see, it (LCA's) just keeps you thinking within the existing product framework, when really you need to get outside of that box and think beyond what you know" (G8).

Lifecycle assessments force these designers to integrate the principles of efficiency into an existing system or product. However, as stated by G8, it is often it may be more useful to approach the issue from the opposite end and look at designing a new concept or product from scratch.

These two designers also felt that if the products had a negative effect during the usage stage of a product, that this impact would be missed by the lifecycle analysis. For instance, questions such as if the product makes meaningful contributions to society, is left out of the equation during the assessment. Again, this may result in producing products with only environmentally friendly benefits but ultimately not provide an overall social benefit. Although lifecycle analysis provides a framework for thinking about the outcomes of a product, for these two green designers, it misses the all-encompassing goals of sustainability and sometimes limits their ability to design something better.

7.4 Summary

In this chapter, we described how green designers reported relying on their intuition and unusual ways of knowing through the design process. Green designers reported that it was ok for their designs to be drawn from personal experiences, as well as skip the user research phase in their projects in the interest of time and instead, trust their intuition. In contrast, traditional designers did not have the same comfort in trusting their intuition. Traditional designers reported relying on rationality and analytical deduction, especially when explaining design choices to management.

We also described how green designers were comfortable with the notion of uncertainty. Green designers did not require a resolution or answer if one was not present, either during design or as an objective of design. Rather, they were comfortable with patience in the design process, as well as confidence in the design process. Uncertainty is sometimes viewed negatively. However, acknowledging uncertainty seems to offer something valuable and quite positive to these green designers.

We also described how two green designers are limited by their creativity and intuition, because of the tools they used, namely lifecycle assessment tools. The tools that are meant to improve the sustainability of a product seem to be hindering the designer's ability to re-invent and create something new.

8 Discussion

As we examine the themes that emerged from our interviews, one question we can ask is how the role of green designers and traditional designers differs during the design process. Essentially, given an understanding of how designers feel they differ, the next question we seek to explore is how these differences play out during design.

In this section, we look at three different aspects of the designer in the design process to understand the distinctions that arose between green and traditional designers. In looking at these three roles, we describe how the role of the green designer is significantly different during the design process. Sometimes this difference may be a source of frustration for green designers, so we also explore the differing trade-offs of green and traditional designers next. Finally, we articular what we feel are the different standards designers are held to.

8.1 Differing Roles

As we note in Chapter 3, the role of designers has traditionally been to create working systems. In our interviews with traditional designers, we see this goal play out through the need for concrete, actionable solutions during design. Traditional designers shun uncertainty and justify their designs by grounding the solutions they propose in data they collect, either from prospective users or from other experts within the organization.

One crosscutting observation about our green designers is that the role of a green designer during design is different. Rather than seeking to create actionable designs, in our study, the green designer's role is to advocate for one worldview, specifically sustainability. Unlike traditional designers, green designers did not feel the pressure to fully rationalize design decisions to stakeholders. This plays out in their ability to accept uncertainty and intuition as rationales for their design suggestions.

At a cursory level, it would seem that green designers should rely less on intuition and more on rationality when advocating for the environment. Green designers must consider a much broader range of factors, such as material sciences, lifecycles, and supply chains, among others. As a result, it seems contradictory that green designers rely on intuition and value their years of experience. However, given the role of advocate for a single attribute of the final design, sustainability, rather than a producer of a workable solution, the green designer is free to act as a foil for design decisions that may have negative environmental consequences, even if no solution is readily available.

The advocacy role that green designers serve is simultaneously more liberating and more challenging. The liberating aspects of green design play out in two different ways. First, the tolerance for uncertainty allows green designers to question and to fail in a way that traditional designers are uncomfortable with. From overall themes of embracing uncertainty to lower level actions of considering what the homeless may reveal to the design of technology, the comfort of green designers to 'go out on a limb' is distinct. Second, green designers were able to draw inspiration from themselves, as opposed to grounding data in design. This played out in their ability to use instinct and intuition versus data and in their articulation of a personal worldview that influenced their green design.

'Intuition' may be something that green designers inherently possess or something that was taught to them throughout their design education. It may also be that they are overlooking their years of experience, and that 'intuition' is actually derived from earlier experiences designing as traditional designers. Still, it seems designers are right to label their way of accessing knowledge as 'intuition', meaning that it is not based on conventional forms of logic. Intuition may be another way of describing adductive thinking, something design researchers have identified as crucial to the logic of design [25]. This logic allows green designers to shift between the goal of the design and more varied forms that satisfy that goal.

The frustrating aspects of green design play out in the need to push, drive, and advocate against economic concerns of the organization. It seems obvious that, at the end of the day, the concerns of green designers may be trumped by the economic needs of the organization. These trade-offs may be a source of frustration for green designers, so we explore the differing trade-offs of green and traditional designers next.

8.2 Differing Trade-offs

In discussions with traditional designers, we did find that environmental sustainability was a concern of traditional designers, but that this concern was balanced against what was viable. Thinking more broadly about sustainability, a modern perspective on sustainability is that sustainability is about more than simply being environmentally responsible. For example, the United Nations Sustainable Development Knowledge Platform identifies sustainable development as development that balances environmental sustainability, economic sustainability, and social sustainability [31]. Traditional designers, while not articulating aspects of economic and social sustainability, were clearly aware that, in their role where the goal of design was a final, profitable artifact, the laudable goal of environmental sustainability had to be balanced against the needs of the company and its shareholders to make a profit.

Green designers, instead, articulated trade-offs that included a need for patience and a need to understand when to advocate and when to step back, listen, and accept others' views. As we noted in our results section, green designers described waiting months to see if something would work or "years and years" to see their ideas come to life. Green designers also adopt non-traditional roles of supporter and catalyst, and they need to sometimes step back from these roles, to give ground, and to listen.

8.3 Differing Standards

Design literature extensively writes about the creative process, and the methods used to stimulate creativity [3][6]. In design education, students are introduced to problem-solving exercises, brainstorming techniques and analytical thinking: however these exercises often fail to recognize that the act of design is uniquely personal to the designer, deeply rooted in their individual lives [6]. This personal nature of design is rarely looked at, or addressed, but must be appreciated if design is to become more sustainable.

Whether a designer is a traditional designer or a green designer, designers are both providing a professional service and exercising creativity. As such, an understanding of the deep, personal nature of design can enhance the designer's awareness of their process, and contribute to their development. Furthermore, by recognizing the basis on which creative decisions are made, designers may be better able to question their work and challenge expectations.

All of the designers we spoke with cared deeply about the products they designed, but the green designers were unique in the ownership they took of their personal investment in design as a process, describing comfortably the spiritual aspects they brought to design. This continued to play out in their trust in the design process. Traditional designers, in contrast, did not express these same spiritual aspects to design, and also expressed distrust in the design process.

It remains an open question whether green designers' roles fostered a spiritual connection to the designs they created, or whether people who wanted a spiritual connection to their designs chose to take on roles as green designers. We suspect the latter. However, regardless of whether green design promoted spirituality and personal investment in design or whether individuals sufficiently invested in design become green designers, the articulation of personal investment and the spiritual dimension of design was unique to our green designers.

Implicit in our data and, in particular, the observation of a personal nature of design is, we feel, an articulation of the different standards designers are held to. Green designers can measure their success by whether they reduced, in any way, the environmental footprint of shipped products. "Good" green design is both a pragmatic and an altruistic endeavor. In contrast, traditional designers measure their success in the practicalities of the real world, specifically metrics such as how many units shipped, or the differential between the price of the product and the cost of the product. "Good" design is about the desirability of the design and the reduced altruism inherent in the commercial success that measures any design's outcome may make traditional designers more hesitant to link their selves to the design work that they do.

8.4 Summary

In this chapter, we described how the roles of green designers differ from that of traditional designers. Rather than designing technological artifacts directly, the green designers role is to advocated for one worldview, specifically sustainability. Unlike traditional designers, green designers felt free to uphold their ideas based on their own experiences, whereas traditional designers felt like

they needed to always defend and rationalize decisions based on data. In this sense, the advocacy role that green designers played was more liberating.

We also described the differing tradeoffs between the two roles. Traditional designers balanced and mediated between the concerns of the business, their stakeholders and environmentally minded designers. On the other hand, green designers articulated a view that sometimes went against a balanced approach, and instead advocated solely for the environment or users. Other times, green designers were very patient in their approach, waiting "years upon years" for the fruits of their labor to be realized.

Finally, we also described the differing standards designers are held to. The green designer's relationship to what they designed was uniquely personal, sometimes going as far being spiritual in nature. These designers measured their success by the amount of 'good' they contributed to the planet, and not about the commercial success of their design. In contrast, traditional designers measure their success by the practicalities of the world, such as how many units have shipped or how much money they have saved the company.

9 Conclusions

This thesis has presented findings from a qualitative study on the practices of environmentally minded designers. The findings described how the practices of environmentally designers differed from those of traditional designers through three themes: the personal nature of design, the roles and relationships of designers and intuition & uncertainty in design. We discussed the differing roles, trade-offs and standards between the two groups of designers. This chapter will review the study's results and suggest future work that could further our knowledge about environmentally minded designers and how they work.

9.1 Research Objectives

As designers have become critical components to the creation of technology, an understanding of the discipline of design has become of significant interest within the field of Human-Computer Interaction (HCI). The partnership between end-users and technology designers is a crucial one. Technology designers make deliberate choices about the utility of products and systems, the materials used, the manufacturing process, the length of useful life, and what happens after a system is no longer needed. They are directly responsible for the sustainability or unsustainability of systems. Yet, very little of the research in sustainability has looked at how designers 'think' through the lens of sustainability. It seems sensible then, to draw upon the accounts of designers to pose more effective and fruitful research questions that would encourage sustainable outcomes.

The question at the core of thesis was how do environmentally minded technology designers employ their creative skills differently than non-green designers. To describe this difference, we conducted a qualitative study. We considered what motivated technology designers to adopt the perspective of sustainability, the differing roles and responsibilities of green designers and intuition and uncertain in the design process. From this data, it was possible to discover distinct differences between environmentally minded designers and traditional designers.

9.2 Findings

The study presented in this thesis draws on interviews with environmentally minded designers at their place of work. Several key findings were identified from the study data;

Pro-environmental Lifestyle: For our green designers, the main source of commitment to a sustainability perspective had to do with their personal lives. Environmentally minded designers' appeared to be just as environmentally minded at home, in their personal lives, as in their professional lives. Green designers all reported practice a number of green behaviors such as monitoring home energy usage, driving less frequently, garden and/or cultivating their own food, reducing the amount of possessions they owned, being mindful of work-life balance and encouraging others to conserve.

Transpersonal Orientation: Another source of commitment to a sustainability perspective was transpersonal in nature – that is a source that transcends green designers. Their spiritual practice appeared to influence commitment to a sustainability perspective as well as a belief that "doing good" was a life calling.

Acting on Behalf of Users: Another source of commitment to a sustainability perspective appeared to be users. Green designers felt a strong motivation to serve their users and the planet. This value was strongly related to the values of equality and equity.

Overcoming Novelty: The commitment to sustainability appeared to influence the design process. For green designers, it helped them overcome the novelty of the technology. In contrast, when talking to traditional designers, it appeared that the novelty of the technology generated an increased interest in design projects.

Less Divergence: Prioritizing environmental values appeared to make the design process less diverging for green designers. In contrast, traditional designers felt a greater tension between the needs of business and the requests of green designers. Traditional designers reported frequently mediating between business needs and environmental concerns, constantly balancing the needs of opposing stakeholders.

Wider Design Lens: Green designers tended to view user issues through the lens of human rights, whereas traditional designers tended to view issues through the lens of accessibility, that is the degree to which a product or feature is available.

Three Roles: We identified and classified the roles of designers into three areas; facilitator, supporter and catalyst. In the role of facilitator, the designer's responsibility was to help the group of stakeholders understand common goals, and direct them towards a common vision, without necessarily taking a particular stance on any issue. In the role of supporter, exclusively held by green designers, designers would take an active stance on issues. In the role of catalyst, also exclusively held by green designers, growth of sustainability initiatives would be driven through conflict.

Serving Multiple Roles: Green designers reported frequently switching between advocacy roles, simultaneously. The most frequently reported transition was from facilitator to either supporter or catalyst, then back to facilitator. The phenomena of switching back and forth between roles seems to go against existing design research that suggests as designers learn to work in a new team, their controversial opinions tend to regress.

Intuition and Unusual Ways of Knowing: Green designers described relying on ways of knowing other than analytical deduction. Green designers reported that it was ok for their designs to be drawn from personal experiences as well as skip conventional phases of the design process, such as user research. In contrast, traditional designers tended to rely on data and rationalize their decisions to management.

Comfort in Uncertainty: Green designers acknowledged 'uncertainty' as a significant part of the design process. Being comfortable with their relationship to 'not knowing', seems to allow green designers greater flexibility in exploring ideas and developing a course of action. In contrast, traditional designers did not have a similar openness to uncertainty.

Limiting Intuition: Two green designers explained how structured approaches to sustainable design, such as lifecycle analysis, actually hinders their ability to design a system that is more sustainable. For two green designers, the current lifecycle tools available miss the all-encompassing goals of sustainability.

9.3 Discussion

Based on our findings, we asked how the role of green designers differs during the design process. We made some crosscutting observations organized through three lenses: roles, trade-offs and standards:

Differing Roles: One crosscutting observation about green designers is that the role of a green designer during design is different. Rather than seeking to create actionable designs, the green designer's role is to advocate for one worldview, specifically sustainability. This plays out in their ability to accept uncertainty and intuition as rationales for their design suggestions. First, the tolerance for uncertainty allows green designers to question and to fail in a way that traditional designers are uncomfortable with. Second, green designers were able to draw inspiration from themselves, as opposed to grounding data in design.

Differing Trade-offs: A second crosscutting observation about green designers is that a need for patience, and an understanding of when to advocate and when to step back and listen, gives ground to their work. In contrast, for traditional designers, the laudable goal of environmental sustainability had to be balanced against the needs of the company and its shareholders to make a profit.

Differing Standards: A third observation was that green designers were unique in the ownership they took of their personal investment in design as a process, describing comfortably the

spiritual aspects they brought to design. This continued to play out in their trust in the design process. In contrast, traditional designers were more hesitant to link their selves to the work that they do.

9.4 Implications & Contributions

We studied and invested in how designers think for two reasons. Firstly, the problems of sustainability require deep involvement from technology designers. In an age of mass technological consumption, designers largely influence how our tools are shaped. Reflect that many resources extracted from the planet, pass through the hands of designers to make new products, services or systems for the mass market. Designers are in a good position to favor recyclability and reuse over extraction for the mass market, and to help create pro-environmental solutions and better conditions for humanity. Thus, it seems sensible to invest in how technology designers think.

Secondly, for the same reasons that we study art, understanding the design process helps us train new people entering design studies. Studying designers through the perspective of sustainability has not been well researched. A rich description of this particular use case of designers offers rich details for anyone interested in green design. Not much is known about the phenomena of green design. We provide a detailed account of what this type of design entails. Green designers question traditional design thinking by going beyond the role of facilitator and acting as supporter or catalyst. Because of this, it seems unlikely that an organization would only employ green designers. Companies still need to balance business needs with environmental outcomes. Green designers are there to represent the needs of the planet, however organizations still need the balance of profitability and environmental outcomes.

As discovered in the study, green designers wear many hats. In order to become an effective change agent, future designers need to be trained on how to make an impact with their design abilities. Contrary to the conventional design program that teaches students how to present a good portfolio, the measures of success, in the context of sustainability, need to be the number of influencers or change agents the education system produces. The next generation of educators will require designers to address the economic, social and environmental well-being of the planet. Education must be structured in a way that cultivates this understanding.

9.5 Future Work

We believe that the findings and analysis reported in this thesis accurately describe the difference in roles between environmentally minded and traditional designers. We feel accuracy was achieved through the data set of three interviews as well as through ongoing consultation with participants. However, there is much information to be desired, both to overcome the limitations of the study as well to further our understanding on sustainable design practices.

The main limitation of the study was a study that focuses on a single critical case, at a large mobile phone manufacturer. Although the case allowed us to study in-depth phenomenon, anchored in a real-world context, this phenomena may only be specific to this mobile phone manufacturer.

Despite this, we feel the study's insights can still be construed as tentative hypothesis in which to base future work. Case studies play an important role in advancing our understanding in nascent research areas. Although the issue of generalization appears larger than other types of research methods, still readers can learn much from a particular case.

Another limitation of the study was the use of a single research method instead of a varied set of methods. Since we did not know what questions to ask initially, an interview method seemed best suited. Additional research methods would have given us a further understanding of how designers work. Future work could include more formal experimental methods, similar to the experiments of Chan [3]. In particular, experimental studies applied in controlled, lab scenario would have helped measure the different cognitive activities between designers more directly. You could imagine giving designers an exercise or joint project to work on. As designers work through problems, we would probe them on their thinking abilities and techniques.

Our observations of green designers sometimes go against what is taught in design education. In particular, designers are taught to defend their design decisions with data, rather than rely on instinct and intuition. Green designers however, tended to rely on their years of experience, often in lieu of data. It is important to note that as researchers, we are not advocating for one approach (ie. data-driven approach) over another. Rather, our motivation is just to report what was observed among green designers. The relationship between intuition and comfort in uncertainty need to be explored further, especially in relationship to data-drive approaches. We need to understand and acknowledge when and how tacit-based information and unusual ways of knowing are valid techniques for designing.

Another area for future work is to look at the various tools and frameworks that would help designers 'design' with the perspective of sustainability. As discussed in Chapter 7, environmentally minded designers criticized the tools they used, as they tended to focus on efficiency gains rather the entire outcome of a system. Perhaps less structured frameworks or procedures would help designers continue to evolve their design capabilities, but would allow for a process that is more flexible and adaptable.

This thesis presented a qualitative study on the practices of environmentally minded designers, and described how their practices differed from traditional designers. The results revealed how commitment to a sustainability perspective influences the design process. The results also revealed the various roles that are unique to green designers. Their comfort in intuition and uncertainty is also unique, as well as the roles, trade-offs and standards between the two groups.

We view this thesis as a contribution to the sustainable design movement within HCI. In helping to shape the outcomes of products and experiences, designers are perfectly positioned to co-create a civilization that flourishes within the ecological limits of the life it supports. Humans excel at solving major problems. We have dealt with the difficulties of food gathering and danger avoidance. We have built structures to provide shelter from the elements, developed agriculture to compensate for the fluctuations of wild food sources, designed laws to organize society and even discovered cures for diseases. In essence, any time there has been a threat to civilization, humans have risen to the

challenge. We hope and believe that rather than becoming victims of global change, values of sustainability can and will eventually form all parts of design.

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Appendix A. Terminology

affinity diagram: A research tool that allows a large number of ideas or data sets to be organized into groups, based on their relationship with each other. A key characteristic of the grouping process is bottom-up brainstorming where related items are grouped together, eventually implying categories, then headings, as opposed to the reverse – determining the headings first, then the categories and groups.

design: As both a noun and verb, this term can refer to the resulting system that was created, or the journey of how it was created. In our work, it can generally be assumed that verb is being referred to. i.e. the design journey, rather than the resulting design.

designer: An individual who specifies the form and function properties of an object. Typically, the object in our research is a technological system.

design methods: The tools used in various stages of the design process, to help designers work through ill-defined problems.

design process: A series of events and steps in which a solution is generated. The process typically consists of a hear, build and deliver stage.

grounded theory method: A systematic methodology in qualitative studies where the first step is data collection, and the last step is a theory, themes or hypothesis.

green technology designer (or environmental minded designer): An individual who creates technology products who considers themselves to comply with the principles of social, environmental and economic sustainability.

human-computer interaction: A field of study in the realm of computer science that looks at the interaction between machines and people.

sustainable design: Creating projects that eliminate negative environmental impacts (ie. zero carbon emissions). These projects may also shift behavior towards-pro-environmental outcomes. Some of the principles of sustainable design are: use of low-impact materials, energy efficiency, durability, bio mimicry and renewability.

sustainable design thinking: The cognitive activities that designers apply throughout the design process through the perspective of sustainability. This style of thinking is generally considered to be empathy, creativity and rationality.

technology designer: An individual who creates technology products, services or experiences. Classically, this has been computer scientists and engineers. More recently, this has encompassed visual designers, information architects, interaction designers, usability analysts and human-computer interaction researchers.

user needs: Requirements for a system that a user believes would solve problems. Whereas requirements focuses on the elements of a system that need to be present, user needs focuses on the requirements relating to goals and aspirations of users.

walk through: A research method whereby participants re-enact or 'walk through' a sequence of tasks that have occurred in the past. The goal is to understand the understand thinking process. Real-life issues and patterns are more likely to emerge.

Appendix B. Study Letters and Forms

The study presented in this thesis received approval from the University of Waterloo Office of Research Ethics.

This appendix presents copies of the research material required by the Office of Research Ethics: the recruitment email to business gatekeepers, email to prospective participants, participant information-consent letter and thank you letter.

B.1 Recruitment email to business gatekeeper

Subject: Research Study
David R. Cheriton School of Computer Science
University of Waterloo

Dear [business keeper],

I have received ethics clearance through the University of Waterloo's Office of Research Ethics for a study on technology designers. The purpose of study is to understand the design practices of technology designers in industry. I would like to invite employees to participate.

Design practice in the corporate world has indisputably surrounded itself with anonymity, so much so that little academic research has looked at Human-Computer Interaction (HCI) as a commercial design discipline. If you choose to participate in this study, the academic community would greatly benefit from understanding designer responsibility and beliefs. Employees at [name of company] would also have the opportunity to contribute their insights to the wider design community.

The study expects to touch on a broad set of themes such as sustainability, organizational culture, designer agency and creativity. Employees would be asked to participate in three interviews. The interview would take approximately 45 minutes.

Participation is strictly voluntary. We do not want to interfere with the participants' daily work. At any point in the study, employees can leave the study or return to it at a later date. I have enclosed a copy of the project proposal. In addition, I can provide all project materials upon request.

This research has been reviewed and ethics clearance has been granted from the Office of Research Ethics at the University of Waterloo. If you have any comments or questions about participation in this project, please contact Dr. Susan Sykes, Director of Research Ethics at the University of Waterloo, at (519) 888-4567 ext. 36005 or ssykes@uwaterloo.ca.

I look forward to collaborating with you on this exciting project.

Sincerely,

Earl Friedberg
Candidate for M.Math at David R. Cheriton School of Computer Science
University of Waterloo
efriedbe@uwaterloo.ca

Edward Lank
Assistant Professor
David R. Cheriton School of Computer Science
University of Waterloo
lank@uwaterloo.ca

B.2 Recruitment email to prospective participants

Subject: Research Study – Looking for Participants

Professor Edward Lank
Earl Friedberg
David R. Cheriton School of Computer Science
University of Waterloo

Dear Technology Designers,

I am looking for designers to take part in a study about technology designers.

As a participant in this study, you would be asked to partake three interviews. Each interview of the study expects to touch on a broad set of themes such as sustainability, organizational culture, designer agency and creativity The interview would take approximately 45 minutes.

Participation is strictly voluntary. For more information about this study, or to volunteer, please contact me at efriedbe@uwaterloo.ca

This study has received approval from University Relations at [name of company]. This study has been reviewed by, and received ethics clearance through, the Office of Research Ethics, University of Waterloo.

Regards,

Edward Lank and Earl Friedberg
{lank, efriedbe}@uwaterloo.ca

B.3 Participant information-consent letter

Research Study on Designers
Professor Edward Lank
Earl Friedberg
David R. Cheriton School of Computer Science
University of Waterloo

Thank you for your interest in our study. I would like to invite you to participate. This study is part of my Master's thesis in the Department of Computer Science at the University of Waterloo and is conducted under the supervision of Professor Edward Lank. Please find below more information of what your involvement would entail, if you decide to take part.

Overview

Design practice in the corporate world has indisputably surrounded itself with anonymity, so much so that little academic research has looked at Human-Computer Interaction (HCI) as a commercial design discipline. The intent of the study is to look at the work lives of designers in the corporate world. The project would help the academic community learn about design activities in industry.

Participation in this study is voluntary. All information you provide is considered completely confidential. You may decide to withdraw from this study at any time. Your name will not appear in any thesis or report resulting from this study, however, with your permission, anonymous quotations may be used. Data collected during this study will be retained for a year on an encrypted hard drive or in hard-copy format, securely stored with only researcher access. After the 1-year retention period, data will be confidentially destroyed

The study involves three interviews. You will be asked questions about your daily activities as a designer in a large corporation. The interview will cover a broad set of themes such as organizational culture, and designer agency. No preparation for the interview is required. The interview is approximately 45 minutes in length and will be scheduled at a convenient time and location for you. You may decline to answer any of the interview questions if you so wish. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis.

At a later time, with your permission we may contact you to conduct one or more follow-up studies. These will be the same format – interviews and observations. You may decide at that time whether or not you wish to continue to participate in the study.

All data collected is considered confidential. Codes, rather than names or other identifying information, will be used in notes and/or recordings. Even though we may publicly present our

findings or publish our results in papers, only the researchers will have access to the data collected. Names and any other identifying information will not appear in any publication resulting from this study. However, with your permission, anonymous quotations and pictures may be used. Notes, images, and/or recordings collected during this study will be retained indefinitely in a secure location in either the researchers' office(s) and/or research facilities.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact Edward Lank at (519) 888-4567 ext. 35786. The study has received management approval to be conducted at [name of company]. This study has also been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at (519) 888-4567 Ext. 36005.

Consent Form

I agree to participate in the study being conducted by Dr. Lank and their student, Earl Friedberg, at the David R. Cheriton School of Computer Science, University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at (519) 888-4567 ext. 36005.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.
☐ YES ☐ NO

I agree to have my interview audio recorded.
☐ YES ☐ NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.
☐ YES ☐ NO

I agree to participate in this study
☐ YES ☐ NO

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

B.4 Thank you letter

Research Study on Designers
Professor Edward Lank
Earl Friedberg
David R. Cheriton School of Computer Science
University of Waterloo

Dear participant,

I would like to thank you for your participation in this study. As a reminder, the purpose of this study is to look at the work lives of designers in the corporate world. The data collected will contribute to a better understanding about designer responsibility and beliefs in the corporate world.

If you are interested in receiving more information regarding the results of this study, or if you have any questions or concerns, please contact me by email at the address listed at the bottom of the page.

As with all University of Waterloo projects involving human participants, this project was reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. Should you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519-888-4567, Ext., 36005.

Sincerely,

Edward Lank and Earl Friedberg
{lank, efriedbe}@uwaterloo.ca