ABSTRACT

The following report investigates the way in which design can influence or change current practices and thought specifically focussing on domestic energy-use. Electricity using products are common place in the home yet electricity is something that is generally designed to be invisible or intangible. Guided by a phenomenographic methodology and critical design the research focusses on the experience of objects and how to create a strangely familiar yet arresting product; specifically focusing on materialising energy in daily life. The resulting design of Nuusense, a power-hungry energy monster, is an intentionally playful, interactive product that aims to tangibly intercept the disconnect with electricity within the home.

KEYWORDS: *interaction, electricity, critical design, phenomenography.*

GLOSSARY/DEFINITION OF TERMS

Terms/Acronyms/ Abbreviations	Definition	Reference
Load-shedding	Scheduled power outages.	(Eskom, 2015)
Domestic	Pertaining to the home or household.	(Oxford Dictionary of English, 2015)
HCI	Human-computer interaction	
EV	Eco-visualisation	(Odom, Pierce & Paulos, 2008)
Ubiquitous computing	Technology embedded in everyday products that communicate information.	(Arnall, 2014)
CT	Current transformer	(Jain, 2012)

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“What we need to question is bricks, concrete, glass, our table manners, our utensils, our tools, the way, we spend our time, our rhythms. To question that which seems to have ceased forever to astonish us. We live, true, we breathe, true, we walk, we open doors, we go down staircases, we sit at a table in order to eat, we lie down on a bed in order to sleep. How? Where? When? Why?”

- Goerges Perec, 1973

CHAPTER 1: INTRODUCTION

1.0 INTRODUCTION

What is energy and how do we interact with it on a daily basis? The aim of the research is to investigate these questions and explore ways in which to materialise this often invisible entity.

1.1 BACKGROUND TO RESEARCH PROBLEM

The topic stems from an interest in the broad debate on the multiple ways in which design transforms our daily lives and how the rapidly growing landscape of technology is changing our realities. There are a number of designers investigating products as physical critiques of current production and marketing models.

The current energy crisis in South Africa prompted a reflection on the way one views energy on a daily basis. If one eliminates the frustration of power outages or load shedding and the consequent realisation of one's reliance on energy-using products, how does one ordinarily perceive energy and relations to energy when not inconvenienced?

According to World Counts, a site dedicated to reporting live feeds on global consumption, between 2010 and 2040 world demand for electricity will increase by 85%. This increase is more than the entire Northern Hemisphere's current use of electricity. Additionally oil reserves are reported to be depleted within 38 years (Larsen, Bjerring Olsen & Emanonilov, 2015).

The aim of the project, therefore, is to create a product that provides an alternative perspective on one's interaction with energy on a daily basis. The purpose is not to merely create an object that tells the user how much energy they consume but rather to change the way they engage with the idea of energy.

1.2 RESEARCH PROBLEM

In what ways can energy be visualised as a tangible experience/ interaction?

1.3 SUB QUESTIONS

1.3.1 What is energy?

1.3.2 What are the different methods for visualising energy?

1.3.3 What is tangible experience?

1.3.3.1 What are the most effective ways to design for tangible interaction?

CHAPTER 2: METHODOLOGY

2.0 PHENOMENOGRAPHY

Phenomenography originates from an educational background in which the creators endeavoured to investigate the varying ways in which students experience learning in higher education. It was developed by Ference Marton and a group of colleagues at the Göteburg University in Sweden in 1979 (Richardson, 1999:53).

The aim of the approach is to investigate the qualitatively different ways in which people experience and understand phenomena in the world around them. The process specifically focusses on the lived experience of others; how they perceive and relate to certain things in their world (Marton, 1986).

Essentially phenomenography is about experience and understanding and the varying ways in which people understand phenomena. The chosen methodology is therefore suited to the focus of this research report as the goal is to investigate how people experience energy and interact with energy-using products. The results of the phenomenographical inquiry will aid the design of a product that engages with the subject in an unexpected manner.

Other methodologies were also considered such as design thinking, experience-based design and hermeneutics. These were deemed unsuitable either due to the prescriptive nature of the research outcome and product or due to the extensive philosophical inquiry. The phenomenographical approach is advantageous as it was originally developed within an educational environment, therefore focussing on understanding, perception and learning (Marton, 1981:2). From the research the final outcome or product could be seen as a kind of learning experience; engaging users with alternative realisations of everyday interaction with energy.

2.1 METHODS

The chosen methods of data collection are guided by a phenomenographic approach. Qualitative methods are used in order to generate insightful descriptions of the way people perceive and experience the world around them and in particular their living environments (Yates, Partridge & Bruce, 2012:102). Semi-structured interviews with a number of different people were conducted in order to gain an initial understanding of how they experience energy on a daily basis. Following on from this cultural probes were designed in order to gain a deeper understanding on the daily experience associated with energy and energy using products.

2.1.1 SEMI-STRUCTURED INTERVIEWS

The interview is one of the primary methods of data collection when using a phenomenographic approach. Marton describes the phenomenographic interview as a valuable interaction between the interviewee and interviewer; a conversational space in which experiences and understandings can be reflected and elaborated upon (Dortins, 2002:209) (Yates *et al*, 2012:102). Essentially the focus of the interview is to gain insight into the varying ways interviewees relate to or experience the specific phenomenon in question. It is therefore imperative that both parties have the same definition of the topic being discussed (Reed, 2006:5).

Semi-structured interviews provide the most suitable space for inquiry and conversation. A few key, open-ended questions are formulated which initiate the conversation and can be used to prompt further reflection on the subject being discussed. This method allows for a greater space in which to explore the topic as guided by the response of those being interviewed (Dortins, 2002:209)(Reed, 2006:5).

The selection of a sample group of people is dependant on the phenomenon being investigated (Yates *et al*, 2012:210). The interview for this research endeavoured to discover the qualitatively different ways people experience energy through sight, sound or touch. Due to the fact that generally people interact with energy and energy-using products on a daily basis, most people were suitable candidates. People greatly ranging in age and occupation were therefore interviewed in order to gain varied responses. All interviews were done in person allowing for better engagement. In addition, interviewees were given the option to answer in whichever way they felt best expressed their thoughts; either talking, writing or drawing. These options were given to allow people ample room to express themselves and their personal experience.

2.1.2 CULTURAL PROBES

Cultural probes are a particularly advantageous research method when investigating the way in which people experience a certain phenomena. First presented in 1999 by Gaver, Dunne and Pacenti the approach focusses on eliciting interesting responses on people's daily lives and thoughts. Born out of the Presence Project the team was unable to engage with their participants as often as they required; The Cultural Probe was consequently developed as a way in which to gain a deeper understanding on the multifarious realities of experience (Gaver *et al*, 1999)(Wallace, McCarthy, Wright & Olivier, 2013: 3441).

Probes are designed objects that entice the user to engage with topics relating to the research at hand. The manner in which they are presented is intended to foster creative engagement with the topic which in turn results in inspiring, unexpected insights into their experience (Walker, Gaver, Boucher & Pennington, 2004)(Wallace *et al*, 2013). In "Cultural

Probes: the value of uncertainty", the authors specifically highlight the need for probes to be playful and evocative devices. The intention is not to gain a comprehensive list of design requirements but rather the results should provide a curious insight into the daily lives and experience of others (Walker *et al*, 2004:54)(Jensen & Stienstra, 2007:256).

This method is particularly relevant to the research which focusses on people's varied experience and interaction with energy on a daily basis. In addition, the results provide unusual, inspiring clues that can prompt interesting results for the design process.

Following on from the process of conducting semi-structured interviews five people were asked to be involved in the cultural probe. The aim of formulating the probes was to engage in someone's daily activities on a deeper level and hopefully gain more insight into how and where one is aware of energy on a daily basis. Photographing is a quick and effective way to document one's experience so an app that could be downloaded to the participant's phone was developed. In addition to being able to upload photos, they could also post comments as well as have a break down of the intentions of the research and some prompting questions such as: "Does energy have a colour?". Some of the questions were purposefully abstract and obscure in order to gain varied and creative responses.

In addition to the app a 'colouring page' and bright koki was provided. The page was covered in rows of light grey vector icons of eyes, ears and hands. The participant was instructed to stick this somewhere convenient in the home. When they were aware of energy they could colour in the appropriate icon. The reason for the poster was twofold as it acted as both a reminder and an easy way for the participant to document their experience. Interviews were conducted with all the participants after documenting their experience for five days.

2.1.3 DATA ANALYSIS

In keeping with the chosen methodology, a phenomenographic approach to data analysis was chosen. This approach results in categories of description being formulated that describe the qualitatively varying ways in which people experience energy (Marton, 1986). The tool is quite similar to grounded theory (Richardson, 1999:68).

The process begins with transcribing the interviews which can then be analysed. Similar ideas or forms of interaction are grouped together in pools of meaning (Reed, 2006:7)(Marton, 1981:196). From this, categories of description are formulated, which illustrate the varying ways in which the phenomenon is experienced. This outcome space should logically relate and involve the minimum descriptions of experience whilst also remaining entirely different to one another. In presenting the outcome space, it should be clear how each category of description relates to each other (Yates *et al*, 2012:106).

2.2 BASIC ASSUMPTIONS/DELINEATION OF STUDY

The proposed study addresses people's interaction with energy or energy-associated products within the home. The research specifically investigates energy pertaining to electricity or power.

The research does not intend to assess energy consumption but rather intends investigating one's experience of energy; this is in order to create a product that engages with the topic in an unexpected manner. Additionally, the research does not intend to be translated into an energy-awareness campaign as it endeavours to delve deeper and question current practices of product and development and how that effects everyday life.

2.3 THEORETICAL FRAMEWORK: CRITICAL DESIGN

The chosen lens provides a conceptual framework which will guide the design of the final product. Critique, engagement and subtle irony situated within everyday experience is presented through the re-imagining of familiar products.

The term Critical Design is credited to interaction designers Anthony Dunne and Fiona Raby whom, up until recently, directed the Interactions Design course at the Royal College of Art in London. The term was first coined by Dunne in his book *Hertzian Tales* wherein he debates the extent of our relations with electronic products through speculative and conceptual designs (1999).

Critical design practices have however been around since the sixties and seventies with Italian Radical Design and anti-design that contested modernist beliefs extending to conceptual design practices in the nineties that critiqued consumer culture and capitalist ideals (Mazé & Redstrom, 2007:3). Critical design practices essentially endeavour to display designs potential and influence on the way we operate in, and view, the world around us. It is far more pervasive and has the ability to transform everyday experience in numerous beneficial and negative ways (Walker, 2011)(Thackara, 2005)(Raby, 2001).

Within their book, *Speculative Everything*, Dunne and Raby present a number of critically engaging works by designers and artists. They provide examples of the ways in which critical design re-interprets the ideals of design. The objects are not meant to affirm current production and consumer models but rather stand as believable fictions or disturbingly possible realities (Dunne & Raby, 2013). Essentially displace current notions of material culture (Walker, 2011:102). The approach rejects capitalist ideals and design for consumer culture but separates itself from a contemporary art practice as it specifically addresses the role of products within the everyday. Expanding on this Raby states that an approach that critiques the agenda of the product design industry will probably not be funded by that industry (2011:272).

Critical Design is therefore considered more of an attitude towards design within daily life, one that critically assesses the way technology and design affects our experiences, attitudes and relations with products (Dunne & Raby, 2015)(Sengers, Boehner, David & Kaye, 2005:51). Projects are based on research into our interactions with everyday products. This results in arresting fictions that are not esoteric and consequently dismissed but rather recognised for their familial but atypical nature (Dunne & Raby, 2013). It aims to spark debate and discussion about practices that are constantly transforming with the advancement of design and technology; assessing new possibilities and challenging preconceived ideas (Malpass, 2012:3).

The aim is to both engage the user and transform the way they view the possibilities of the present, through designed artefacts. The designers highlight the need for such design to provide pleasure; to truly be effective the user needs to be engaged in an experience (Raby, 2011:272). It is meant to be seen as part of a parallel world, believable in its familiarity but at the same time strangely arresting. Some terms coined by the duo include the ideas of 'para-functionality', 'post-optimal' and 'user-unfriendliness' (Dunne & Raby, 2015).

It is necessary to note that such an approach does not intend on designing absolutes rather its value lies in its provocative nature providing alternative concepts on how we might engage with design for

a different material culture. Raby discusses this idea in, *Design Noir: The secret lives of electronics*, by comparing product design to cinema. Instead of falling within the realms of a popular Hollywood blockbuster, critical design explores the idea of Design Noir. A genre that engages with the psychology of our experiences offering products that encourage reflection and questioning (Raby, 2011:270).

The approach is credited in many accounts within critical practices of design and HCI and has served as inspiration for many other alternative approaches (Arnall, 2014:103)(Pierce, 2009:4460)(Backlund *et al*, 2011). It is however not without critique. Reflective design developed by Sengers *et al*, adopt many of the values inherent in critical design but are cautionary in total appraisal. They argue that the provocative nature of the approach can be lost if people miss the subtle irony (Sengers *et al*, 2005:51). This is therefore something to consider and remain conscious of when designing the final product.

2.4 TIMELINE

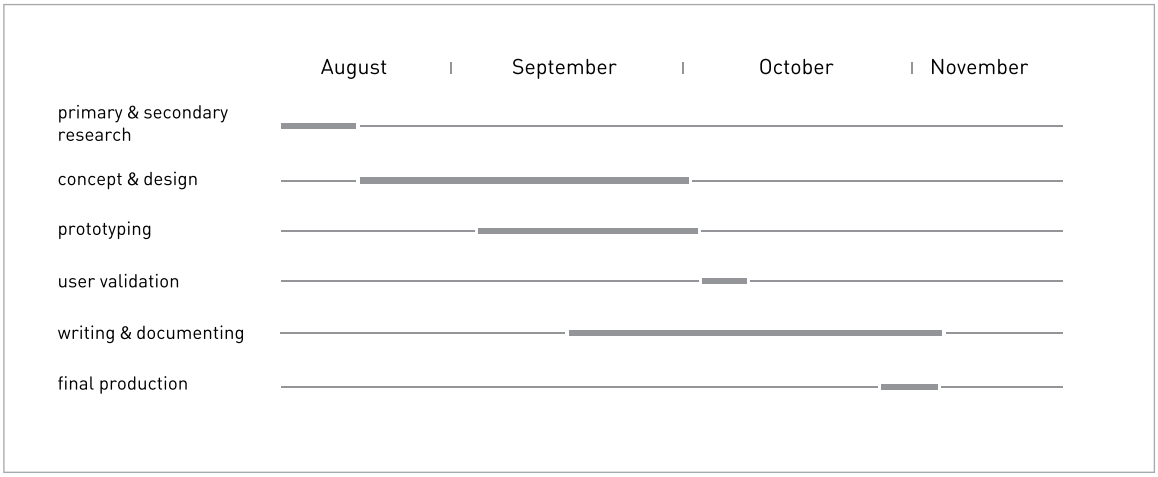


Table 2.1: Timeline.

CHAPTER 3: LITERATURE REVIEW

3.0 INTRODUCTION

The following review expands on the proposed topic of research discussing the main knowledge within the field. The chosen authors investigate the key components within the research problem by first addressing the ambiguous nature of the term 'energy'. Methods for visualising energy are then discussed detailing a number of product examples and theories that have guided the different designers. Finally the review addresses what it means to design for tangible experience again referencing a number of different designers as well as providing a number of product examples.

3.1 CONTEXTUALISING ENERGY

The dictionary definition of 'energy' provides three different meanings. It is therefore imperative to define the energy on which this research will be focused. Briefly addressing the varying meanings, number one pertains to physical and mental vitality either required to perform a task or the amount possessed by a being. Number two refers to the power that is created from varied resources in order to provide electricity (solar energy, nuclear energy etc.) Number three refers to energy as it is described within physical science; basically the capacity to do work (Pearsall, McPherson & Holden (eds), 2014).

In their article, "Materializing Energy", Pierce and Paulos discuss this ambiguity and the innumerable conceptions of the term 'energy'. Within the physical sciences energy as a term is well-defined; an indication of the amount of work that can be done. It is bound by the law of conservation of energy that states that energy can neither be created nor destroyed; one of the fundamental principles in all the sciences. Additionally they add that energy is essentially a characteristic of all physical objects (Pierce & Paulos, 2010:5).

Whilst the physicists have a clear conceptualisation of energy, everyday society does not share one

universally understood meaning. This is pointed out by social psychologists Stern and Aronson and later confirmed by the authors' own research performed with a range of participants (Pierce & Paulos, 2010:5). Addressing the question "what is energy?" they gathered a range of objects which were used to prompt the conversation with the different groups. The results clearly showed that participants had greatly varied ideas and often changed their minds during the discussions (Pierce & Paulos, 2010:5).

This brief assessment of the term 'energy' emphasises the need to define its use for the context of this research. While it is necessary to mention the different concepts, the chosen research focuses on the capacity to perform work, as defined in physics, specifically referring to the electrical power, that powers our everyday existence. The often invisible entity that travels through the plug points bringing to life a multitude of appliances and technological objects (Backlund, Gyllenswärd, Gustafsson, Ilstedt Hjelm, Mazé & Redström, 2006).

3.2 VISUALISING ENERGY

The subject of energy as a design trait has been investigated by a number of designers and researchers. The reasons for their research range from influencing sustainable behaviour to debating the role of energy-consuming products within everyday life (Gabrys, 2012). Two different methods for visualising energy will be discussed; the use of energy monitors or devices that inform users on their energy consumption and, alternatively, the use of energy as a design material in engaging, provocative products.

A project that investigated the domestic behaviours and associations with energy and energy use was conducted by Schiano, Pierce and Paulos. Detailing the process and results within their article, "Home, Habits and Energy: Examining Domestic Interactions and Energy Consumption". The research examines different household's daily interactions with everyday energy-consuming products. Their focus is on investigating ways in which to influence sustainable practices so they specifically focus on energy conservation and related habits within the home. What is of interest is the results of their qualitative study as well as the reason for analysis. Their research and analysis was guided by philosophy and design theory that investigates the influence design and technology has on our perceptions and actions in daily life (Schiano, Pierce & Paulos, 2010:2).

What the study highlighted is that people did not respond to either cost incentives or energy monitoring devices generally stating that it was not of much interest or that it was not going to influence the use of less electricity (Schiano *et al*, 2010:4). Gabrys echoes this within, "Cosmopolitics of Energy" an article that reviews the varying ways in which energy has been visualised across design and art. The author highlights the inadequacy of energy monitors and similar devices when effectively designing for energy visualisation (Gabrys, 2012:8). As highlighted in her review, interaction and unexpected engagement is advantageous in exploring the subject.

The concept of eco-visualisations is discussed by Odom, Pierce and Paulos in their article "Energy Aware Dwelling: A Critical Survey of Interaction Design for Eco-visualisations". The term is largely credited to the artist and designer Tiffany Holmes who first used the word to describe unconventional ways in which to promote sustainable behaviour (Odom *et al*, 2008:2). Essentially an eco-visualisation or EV is an interactive device that translates energy use into tangible products or installations. The authors primarily focus on an EV's role in promoting

sustainable behaviours though the visualisation of data in alternative forms (Odom *et al*, 2008).

Surveying a number of examples the authors outline feedback types, use-contexts and a number of different strategies for designing EVs. Within each strategy they refer to products that were developed within the STATIC! project such as the Energy Aware Cord (fig. 3.1) and Energy Curtain (Odom *et al*, 2008: 6).

The STATIC! project is referenced countless times in a number of other articles that discuss the idea of energy as material or a feature with which to design (Odom et al, 2008:6)(Pierce, 2009: 4461)(Pierce & Paulos, 2010) Static! is a design research program funded by the Swedish Energy Agency (Backlund *et al*, 2006:2). The aim of the project was to create an awareness and critical reflection on energy use and its representation within products. The main concepts directing the research was the idea that both the technical and aesthetic attributes of energy can be fused, challenging the ideas of it being only a part of engineering or design (Backlund *et al*, 2006:2), and secondly that products can represent alternative perspectives and not merely be about function and use.

Integral to the research was the notion that energy occupies two disparate realms that of: engineering (invisible force behind a product), and the aesthetics (design around the energy such as lampshades and glass bulbs) (Backlund *et al*, 2006:3). Within the research, the authors investigated the use of energy as a material within design, as opposed to just a source of function or invisible force.

The research they conducted involved focus groups and interviews in which they discussed the varying ways people view energy in their daily lives and how it could possibly be conceptualised as material. One such outcome was the idea that one participant highlighted of the apparent duality of lighting as both providing light but also emitting a certain amount of heat. This idea lead to The Radiator (fig. 3.2), whose form is reminiscent of a radiator heater but the elements are replaced with incandescent light bulbs, in this way transforming the way in which one thinks about energy using products and the ways in which it can be used represented in the home (Backlund *et al*, 2006:5).

The law of conservation of energy states that energy can never be made or destroyed, rather it can only change form (Backlund *et al*, 2006:6)(Pierce & Paulos, 2010:5). The law therefore prompts one to reflect on the numbering ways in which energy presents itself. With the resulting products within the project, one realises how this can be used to conceptualise unusual but still familiar materialisation of energy. The idea of heat being displayed as lighting or as movement reflecting a sense of transformation with the solar curtain. The Energy Curtain incorporates renewable energy technologies with known materials to create a form that is familiar to the viewer but acts in a unexpected but logical way (Backlund *et al*, 2006:4). During the day the curtain harnesses solar energy which as darkness begins to fall, this energy is used as the curtain gradually illuminates the room. This similarly integrates a sustainable approach with that of a speculative attitude.

A third design, The Power Cord (fig. 3.1), the most widely referenced example from the project, is relatively simple in its design yet highlights the different ways energy presents itself in daily life. When plugged into the wall the electroluminescent wire lights up. Simple yet effective in visibly articulating the idea of energy cursing through the

Figure 3.1: Energy Aware Cord. (Interactive Institute, 2005)

Figure 3.2: The Radiator. (Interactive Institute, 2005)

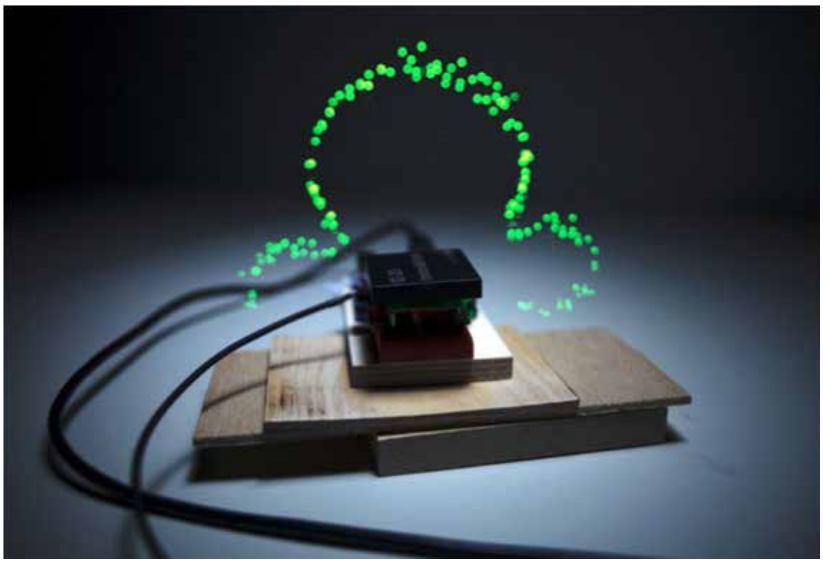


Figure 3.3: RFID 'ghost'. (Touch, 2013)

Figure 3.4: Nuage Vert (HeHe, 2008)

wires from the mains and the plug points into the corresponding product (Backlund *et al*, 2006:7).

Similarly to the Static! project Pierce and Paulos investigate the materiality of energy as generally these are seen as two separate entities within HCI and interaction design. The research involves both a literary investigation of energy and materiality as well as an exploration of design artefacts. By conducting interviews, focus groups and cultural probes they investigated to what extent energy can be materialised. Again similar to Static! their method of enquiry was that of a critical nature, one that intends on provoking a response or changing attitudes (Pierce & Paulos, 2010).

From their research they developed a framework for designing with energy as a material: collecting, keeping, sharing, activating. The Energy Mementos were the resultant designed artefacts that visualised the different interactions though small objects. The objects allowed the user to collect and activate small amounts of energy. One example is the Crank-Sound Box, a box no bigger than fist-size with a crank on one side. Turning the crank in one direction records the sound, turning it in the other direction plays the sound back though a small speaker on the opposite face (Pierce & Paulos, 2010: 6).

Another design that developed out of their project was The Local Energy Lamp which subtly changes colour according to the source of power or type of energy being consumed (Pierce & Paulos, 2010: 8).

Although not exactly addressing the visualisation of energy related to electrical power the Touch project adds insight into the idea of designing with 'immaterials'. The five year long project, Touch, investigated the design and technology of Radio Frequency Identification (RFID) guided by product design approaches and exploratory interaction. One of their projects explored the 'immateriality' of RFID and the technology that was largely undocumented. Using the technique of light painting they produced a set of images (fig.3.3) that clearly show the field of interaction between the RFID tag and the reader (Arnall, 2014: 109).

The idea of visualising energy has not only been addressed in the design of everyday products; larger social interventions have taken place including Nuage Vert (fig. 3.4). The installation was developed by HeHe, Helen Evans and Heiko Hansen, whom endeavoured to highlight the often invisible emissions from Salmisaari, an urban power plant in Helsinki. According to real-time energy consumption laser projections were mapped over the power plant's cloud. In this way visualising the energy consumption and highlighting local use (Gabrys, 2012:12)(Odom *et al*, 2008:2).

Another project that is currently being developed by Bjarke Ingel is BIG's Amager Bakke, waste-to-energy plant due to be built in Copenhagen. The power plant will visualise energy consumption for residents through a chimney that blows smoke rings every time 250 kilograms of carbon dioxide has been released into the atmosphere (Frearson, 2015).

What the aforementioned projects display is the numerous ways in which energy can be interpreted and visualised, highlighting the vast potential for such a project. The strength in many of the projects is the "familial strangeness" of the objects, or use of engaging and unexpected methods of visualisation. Overall the discussion advocates for creative and innovative approaches to transforming behaviours and presenting energy use in new ways with the aid of technology.

3.3 DESIGN FOR TANGIBLE EXPERIENCE

In order for something to be considered tangible it needs to be perceptible by touch. Tangibility refers to anything that can be detected by any of the senses. Tangible experience could therefore be considered an integral part of product design as physical interactions play a key role in our experiences with objects (Pierce, 2009)(Klemmer, Hartman and Takayama, 2006)(Lim, Stolterman, Jung and Donaldson, 2009).

Many of the projects that have already been discussed address intangibility present within technology and design. The project, Touch, explores the use of invisible technology within products and how to design with these as materials. Although their project specifically investigates the design and technology of Radio Frequency Identification (RFID) their approach and outcomes illustrate an approach to designing for tangible experience (Arnall, 2014).

The multi-disciplinary team explored the varying ways in which this technology could be used in the design of products that oppose ubiquitous computing practices or the invisibility of technology in products. As the author states "contemporary visions of technological development increasingly focus on invisibility and 'seamlessness'" (Arnall, 2014:104). The term 'immaterial' resulted from the project and describes the way in which something can be invisible yet still shapeable; essentially describing their aim to "provoke and build understanding around compositional character of invisible design materials." (2014:105)

Of interest is the product or prototypes that were developed during the project. The first set of prototypes were playful in nature using the technology of RFID in unexpected ways. This included the Sniff dog toy (fig. 3.5) and the Bowl prototype (fig. 3.6)(Arnall, 2014:108). Noted by the author, these products reflect the attitudes of critical design. In opposing the idea of seamlessness and invisibility they challenged contemporary themes of technological development as well as provided examples of design for tangible experience (Arnall, 2014:107).

Klemmer *et al* describe an approach used to create an awareness of the role active, bodily interaction plays and its integral role in the way people experience, specifically focussing on interface design. Interaction design students were made to make tangible, interactive sculptures which would then inform the design and use of their interface. This process emphasised the integral role the body plays in understanding objects reflecting the idea of making sense instead of thinking sense as mentioned by Klemmer *et al* in, "How Bodies Matter: Five Themes for Interaction Design" (2006).

Similarly the authors highlight the importance of the body when designing for interactive systems. Human beings learn by doing and interacting with tangible artefacts. An idea similarly expressed by Pierce and Paulos with their Energy Mementos (2010:6). Klemmer *et al* provide examples substantiated with theoretical research that illustrate the importance of considering physical interaction, not just mental. The focus is primarily on designing for tangible interfaces, yet this can inform this research report as it highlights the innate importance of bodily interaction that contributes to cognitive processes and awareness. It additionally adds to the experiential nature of the artefact (Klemmer *et al*, 2006).

They additionally comment on the reflective practice in design which is learning through making and doing, not just thinking. They highlight the

Figure 3.5: Sniff (Touch, 2013)

Figure 3.6: Bowl (Touch, 2013)

importance of tangible prototypes in the design process as it engages the designer on another level of understanding and interaction, augmenting the experience and enhancing the results (Klemmer *et al*, 2006:142). Essentially physical interaction with tangible things increases user experience and understanding.

Wiles' graduate project, *Involuntary Pleasures*, explores the physical actions that increase happiness and pleasure through a range of products. The huggable toaster (fig. 3.7)is one example which requires the user to hug the object close to their body in order to receive their morning slice of toast. A hug induces a number of chemical reactions within the brain leaving one feeling comforted and happy (Wiles, 2015)

Figure 3.7: Huggable toaster (Wiles, 2015)

Desmet and Hekkert, professors in Industrial Design at the Delft University of Technology, provide a framework for product experience which outlines three levels; aesthetic experience, experience of meaning and emotional experience. The paper investigates the varying ways the subject of experience, specifically related to human-product interactions, have been addressed in different fields and the ways in which it can contribute to the design of products for more affective interactions. Unpacking each level the authors provide tools for designing for such experience (Desmet & Hekkert, 2007).

Dalsgaard references Desmet and Hekkert's framework for product experience as he discusses its role within interaction design. The author highlights the numerous conceptualisations of experience but chooses to focus on design for inquisitive use as it adds to the experiential nature of the product as well as highlights the importance of the user or experiencer (Dalsgaard, 2008).

The idea of conflict, inquiry and challenge are addressed discussing their influence on the user's experience. Of significant relevance to the topic at hand, the author highlights the advantage of unexpected results which echo Critical Design intentions. The author also highlights the important role of context and recognisable forms within an interactive system. If one is to engage with an artefact or installation there needs to be something familiar, the surprise or challenge follows in its response (Dalsgaard, 2008:23).

The idea of ludic design is echoed in Dalsgaard's approach. A critical design approach developed by William Gaver. He describes it as designing for homo ludens; considering people as playful creatures who thrive on pleasurable interactions that involve curiosity, exploration and reflection (Gaver, 2002). The Drift Table is a product created during the Equator IRC project which used cultural probes to investigate 'domestic experience' in London in 2000 (Gaver, Bowers, Boucher, Gellerson, Pennington, Schmidt, Steed, Villars & Walker, 2004:3).

The Drift table is a small, square coffee table with a viewpoint on top which displays moving aerial photography of the British countryside. Any objects placed on the table effects this display inviting

the user to experiment and engage in an unlikely manner. The Size, weight and position of the objects all influence the movement such as speeding up the scrolling image or retreating further into the sky (Gaver, 2002). This example illustrates how playful conceptions of everyday objects can transform one's tangible interactions and consequently inspire reflection on the possibilities afforded by design.

Inspired by critical approaches to design, including ludic design, Pierce presents a material awareness perspective that encourages more meaningful and engaging design of interactive everyday products. His approach ultimately advocates and critically highlights the need for designs that prompt reflection on everyday things as well as the desirable influence on experience (Pierce, 2009:4460).

Explaining the development of his approach he provides a philosophy of interaction with objects that includes: embodiment, hermeneutic and aesthetic interaction. He highlights the fact that generally technology is intentionally designed to disappear into unconscious experience (Pierce, 2009:4462). Material awareness proposes a way in which to design objects that intentionally draw attention to themselves in some way and in doing so encourages reflection on the way we experience and interact.

One example he provides is the Animate Lamp. When left on it gradually starts to dim its light as if getting tired. Shaking the lamp causes it to abruptly brighten as if startled. Gently rocking the lamp causes it to glow displaying patterns woven within the shade (Pierce, 2009:4464).

Another project similar in nature to the Animate Lamp is the work of ECAL students within a project titled, Delirious Home. This saw a collaboration between industrial and interaction design students who proposed playful reinterpretations of the role of technology within our daily lives. Some of the products included Bonnie & Clyde, a spoon that incessantly follows the tea cup around the table as well as Mr Time (fig. 3.8) whose arms change to mirror the person standing in front of it (ECAL, 2014).

Figure 3.8: Mr Time (Pereyre, Pondard & Zambaz, 2014)

Finally a product example, that encourages tangible interaction through interesting material use is foiLED again designed by Marcus Tremonto (fig. 3.9). A piece of formable copper is embedded with a number of small LEDs allowing the user to mould and shape the light into whatever form they desire (Senda, 2015).

Figure 3.9: foiLED again (Tremonto, 2015)

In conclusion, the reviewed research and product examples highlight a number of key aspects to remain cognisant of when designing alternative conceptions of the everyday. Firstly a clear definition on the context of energy is necessary. An understanding on various methods for visualising energy can inform and guide the most advantageous and successful avenues for exploration. Finally designing for tangible experience requires a consideration on a number of factors which includes the role of the body, mind and context.

CHAPTER 4: FINDINGS

4.0.1 SEMI-STRUCTURED INTERVIEWS

Sixteen informal interviews were conducted where the participants were asked how they perceive and experience energy on a daily basis, specifically in relation to how they see, touch or feel it. These were recorded and later transcribed highlighting their individual responses under what energy looks like, feels like or sounds like. In keeping with the chosen phenomenographic methodology the analysis investigates the qualitatively varying ways in which the participants experience energy.

Prior to asking the questions, a basic outline of the project and the intentions of the research were explained. Energy was clearly categorised for the interviewee to avoid confusion and ensure the results would be of relevance to the research. Interviewees were given the option to answer in whichever way they felt best expressed their thoughts; either talking, writing or drawing. These options were given to allow people ample room to express themselves and their personal experience.

Conversation was guided by three main questions:

In your experience what does energy

1. Look like?
2. Sound like?
3. Feel like?

Finally, is there anything else you'd like to add?

People asked were all of varying ages and professions. This was done in an effort to gain as many different conceptions of energy within the home and in daily life. Those interviewed ranged between the age of 19 to 80 years and their occupations covered a vast array of professions including creatives, academics, business owners, an engineer, a doctor and service industry professionals. Overall the results of the interviews gave an initial insight into whether people are aware of the way they experience energy on a daily basis.

Reflecting on the interviews highlighted the three most prominent ideas; people saw energy as light,

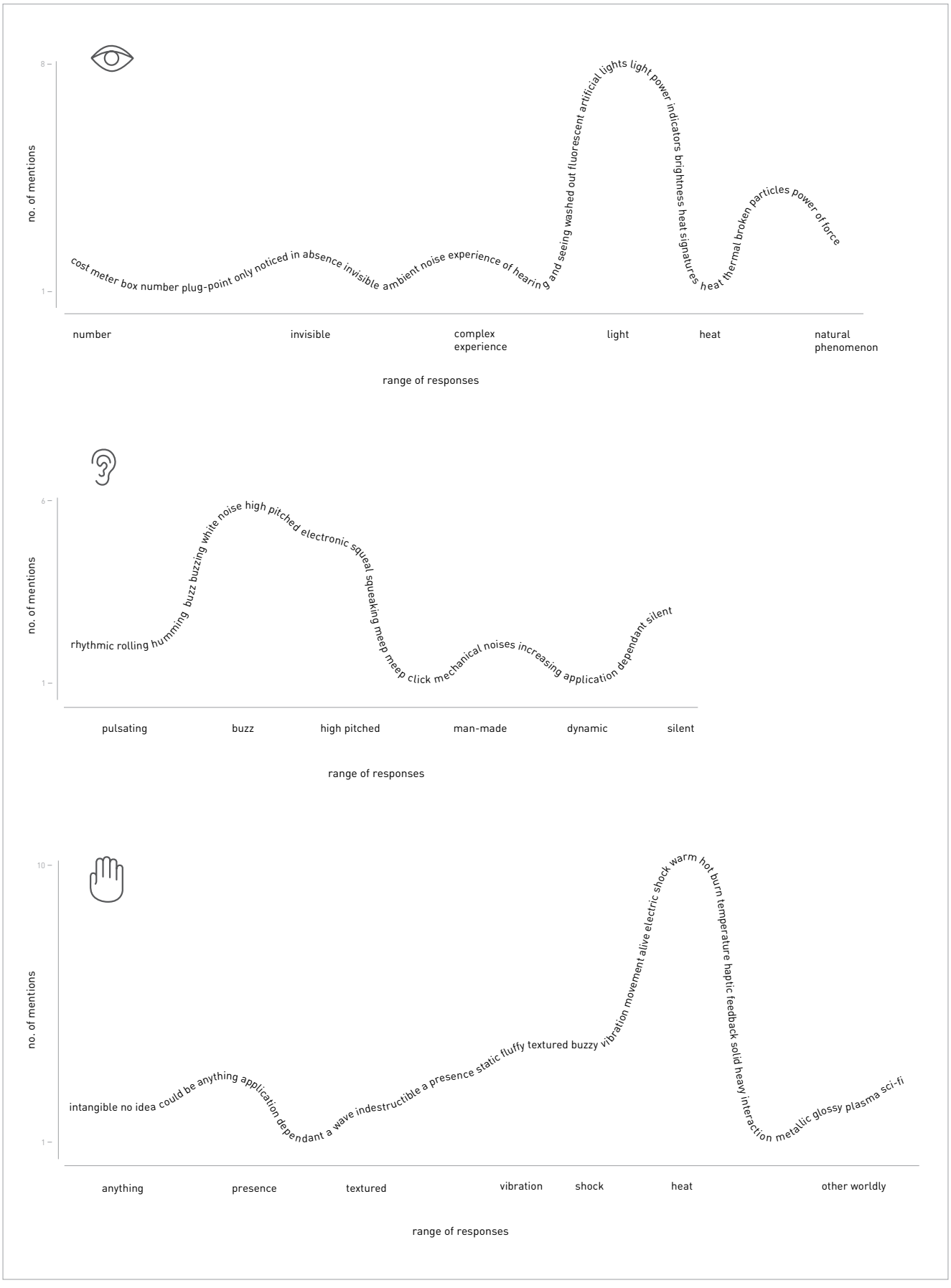


Table 4.1: Word snakes: qualitative graphs.

felt it as warm and heard it as a buzz. Reviewing the transcriptions and breaking down the responses into categories or pools of meaning then engaged with the nuances and creative responses that differed from the obvious.

In order to make sense of this information a common data visualisation tool, graph, was revised to illustrate the findings and extrapolate pools of meaning. The 'word snake' (table 4.1) plots the range of responses showing the number as well as the varying ideas and how they relate to one another. This was a useful way in which to clearly plot significant meanings and perceptions people assign to energy and the extent to which they differ between the specified forms of tangible experience. Reading the words along the 'snake' highlights the differing explanations and responses whilst the height indicates the number of times they were mentioned.

The three graphs clearly show where there was the greatest variance in responses with touch being the most, followed fairly closely by sight. Sound however is far shorter indicating the similarity in conceptions. It is interesting to note certain recurring themes throughout the set with the description of energy as silent, invisible or a presence. Secondly energy as a complex experience, dynamic or anything.

4.0.2 CULTURAL PROBES

Five people took part in the probe. They were all chosen due to their different professions, ages and interests. This was done in an effort to gain a varied set of results. Each participant was given a guide to the probe detailing the intentions of the research, a definition of energy as well as how they could document their experience.

All photos and comments were uploaded to the app whilst the poster provided a quick way to simply document their experience by colouring in the appropriate icon (fig. 4.1). Once they'd documented their experience for five days a conversational interview was conducted in order to gain further understanding of their 'energy experience'.

In all instances the post-interview was extremely informative. The documented results further informed how people experience energy and in all instances the participants stated that they were far more aware of energy on a daily basis. Many of them noted that prior to doing the probe they thought that they were quite conscious of the way they used electricity but this changed considerably over the five days (CB.01)(CB.03)(CB.04)(CB.05).

A basic breakdown of the posters (fig. 4.1) indicates that sound was the most prominently documented with an overall 19 colour indications. Touch follows closely with 18 and then sight the least at 14. During the interviews all of the participants confirmed that sound was something that made them very aware of energy. Load-shedding was a constant reminder of our reliance on electricity with CB.05 noting the silence during these times (appendix B).

Assessing touch most participants mentioned either heat or cold as something that made them aware of feeling energy. CB.04 highlighted the dangerous aspect to electrical power:

"I'm just very scared of electricity and touching [it's] a dangerous touch."

In addition noting that interaction with plug points and switches doesn't influence the experience of 'touching' electricity saying:

"Flipping the switch is almost such a small thing." (CB.04)

Figure 4.1: Cultural probes (image by author)

If they had to give energy a materiality CB.04 said it would be something like a gravel road or rough sand-paper, something very textured. CB.05 similarly saw it as having a very textural feeling describing it as fuzzy or fluffy.

Results from the app include a number of images of appliances, electronic goods and city lights. The description that accompanied some of the images were of great interest as they gave further insight into the participants experiences and ideas surrounding energy use on a daily basis.

An image taken by CB.04 (fig. 4.2) articulates the multitude of wires and plug points needed for an ever expanding technological and energy-using products. During the interview with the participant they expanded on this idea saying,
"There's also something interesting about leads and extending electricity." (CB.04)

The use of laptops and phones was noted by CB.02 and CB.04 as something that didn't necessarily form part of their energy experience. This was said to probably due to the fact that they are continually in use. CB.05 mentioned the noisy of fan of laptop as a constant reminder of energy. Yet once again not pertaining to its use but rather a sound that made them aware.

The more abstract questions seemed to be avoided during the probe. Participants rather displayed pragmatic responses to the investigation by taking photos of appliances and city lights. However, post-interview these ideas were approached asking about what colour they view electricity to be and whether it has a persona?

Warm colours were generally associated with electricity including red (CB.01)(CB.03), yellow (CB.02), sparkly orange or silvery (CB.05) and pale blue or yellow (CB.04). CB.02 noted that she was "thinking of colours a lot" and relating experiences to a specific hue.

The idea of a persona was acknowledged by two of the participants who gave a very clear, vivid image of the way they view energy as a persona:
"It reminds me of somebody who is very alert and organised and on the ball." (CB.03)
"Its like ... a cult leader, you better think, you can't mess with it, don't take it for granted. Also be aware of it." (CB.04)

Figure 4.2: Wires (CB.04)

4.1 DESIGN REQUIREMENTS

The following requirements will guide the design and development of the final product. The approach endeavours to explore energy differently to how people ordinarily perceive it. Results from the interviews and probes will therefore be used as inspiration during the design phase as opposed to required outcomes.

Be familiar yet unexpected in nature. (Dunne & Raby, 2013)

The key to designing for speculation or critique is to situate the commentary within the design of recognisable products or objects.

Feedback. (Lim *et al*, 2009)

The success of an interactive design relies on appropriately designed feedback; how does the object react to the user.

Engage the user in a tangible experience. (Klemmer *et al*, 2006)

The user should be encouraged to actively participate with the product.

Use energy as a design material. (Arnall, 2014)

In order to make the invisible, visible.

Not harm the user in anyway. (CB.04)

Touching live electricity can be fatal so the product has to be safe to use.

4.2 DESIGN PROCESS

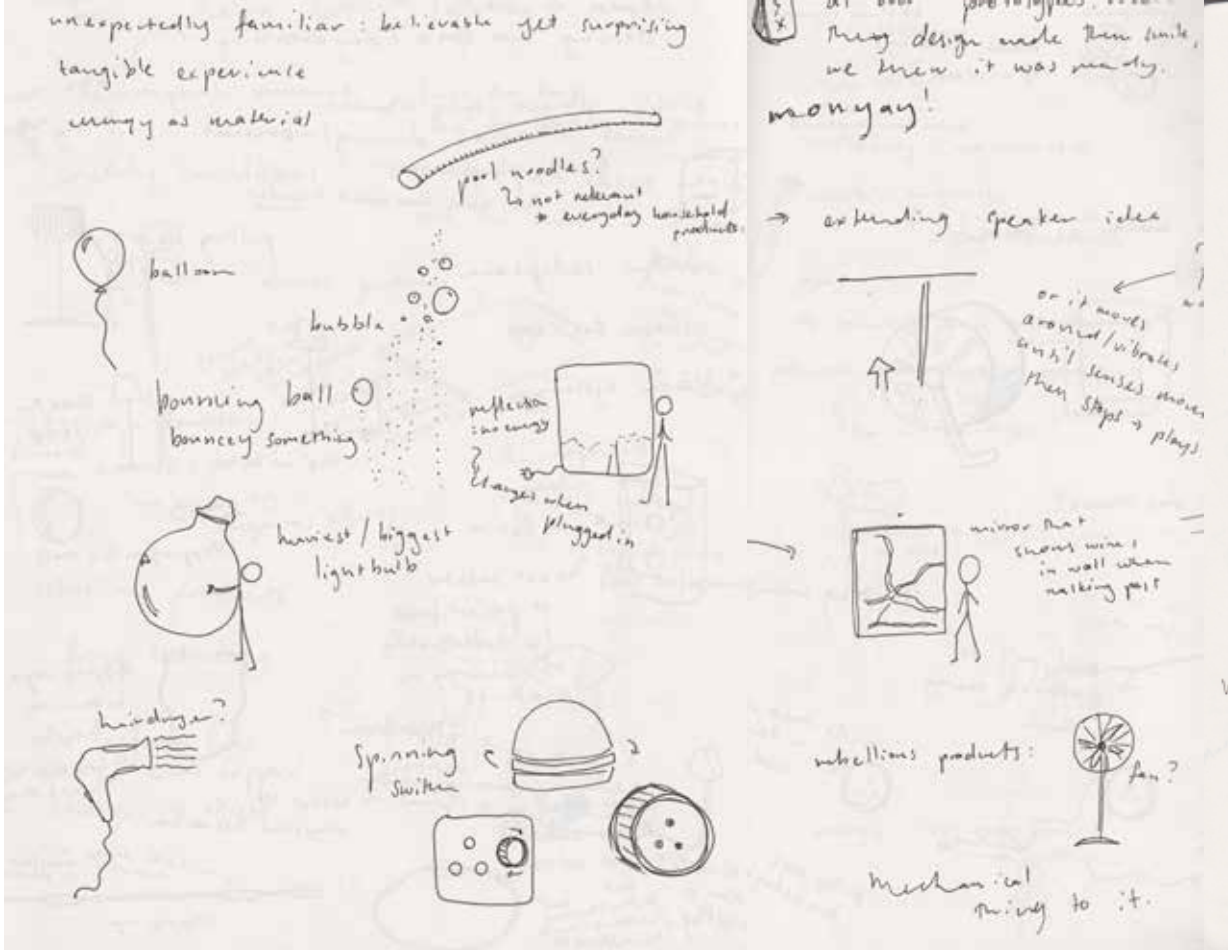
Beginning the design phase, the object could now be conceptualised paying close attention to the requirements. The form and interaction play a pivotal role in the success of a speculative or critical object. The process therefore began with investigating alternative, unexpected ways in which to interact with energy. Familiar everyday household products were coupled with unusual or playful forms of interaction. These initial ideas included a tug of war extension lead, pull-string plug point and heat signature mirror.

In order to inform the conceptual development of the product, additional research was conducted on the amount of energy products consume. It was discovered that the common energy unit, calorie, is the amount of energy required to heat 1ml of water by 1 degree centigrade (Murphy, 2012). Translating this into human effort highlighted how much energy it takes to boil the kettle, for just one cup of water. This then led to the idea of power-hungry appliances.

The concept of the Energy Monster was consequently born. An object that is hungry for one's effort and engagement in turn becomes a product that intercepts one's disconnect with electricity.

A common tool used for tracking energy use is an energy monitor. Yet, as discussed in previous literature, it has been found to be unsuccessful in influencing or changing the way people view energy use in the home (Schiano et al, 2010: 4) (Gabrys, 2012:8). An energy monitor simply gives a reading and approximate monetary values to one's energy use. The Energy Monster, however, is needy and requires the user to interact with it in order to gain any results. It similarly intercepts the appliance's connection with the main power source yet translates the appliance's hunger for energy into a physical interaction.

In order for the appliance to start working, the product requires a certain amount of effort from the user. The user therefore has to feed a certain number of weights into the Monster until it is satisfied. The potential energy (PE=mgh) of the



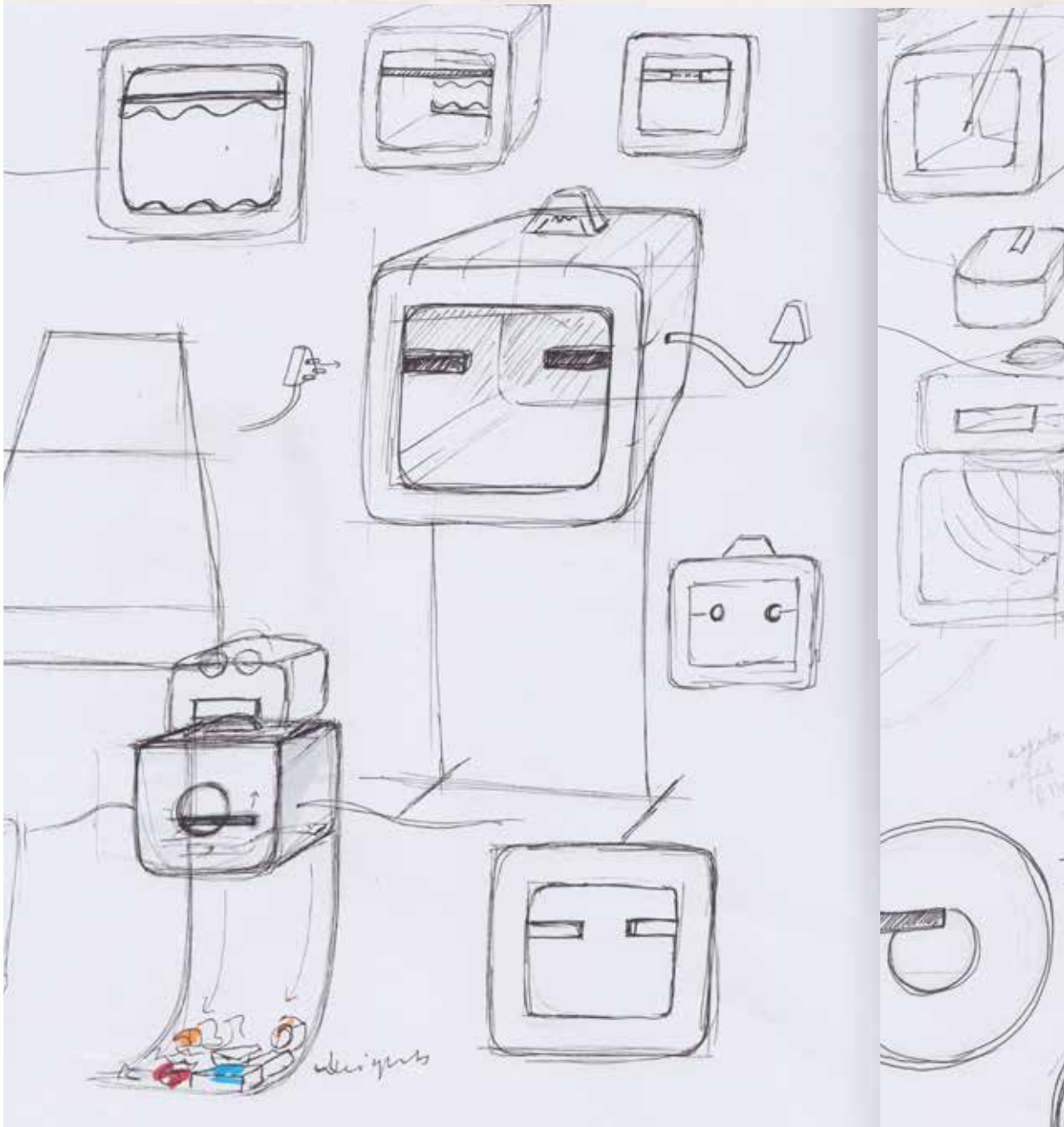
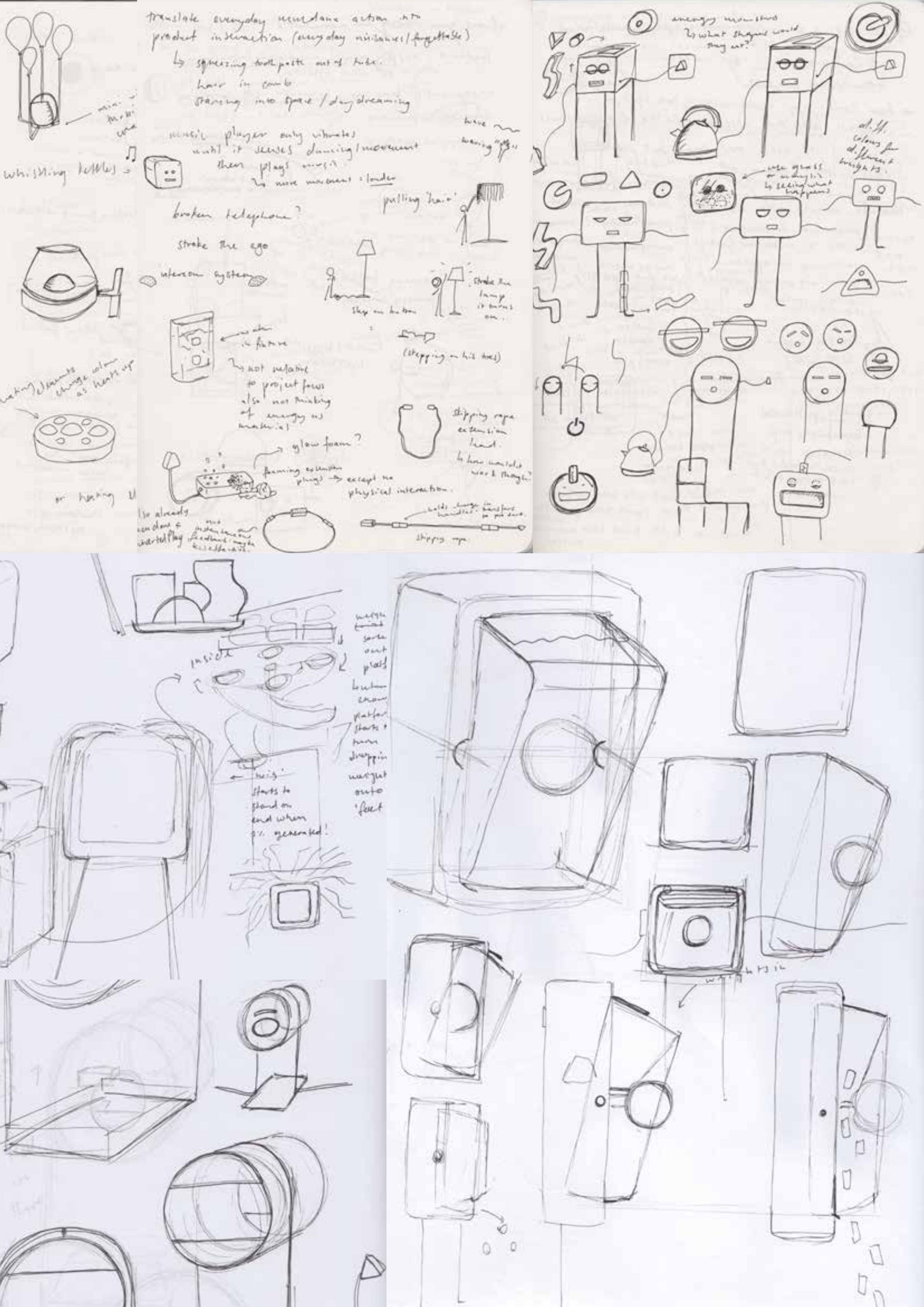


Figure 4.3: Process sketches (images by author, 2015)


whistling kettles
translate everyday mundane action into product interaction (everyday nuisances/forgettable)
squeezing toothpaste out of tube.
hair in comb
staring into space / daydreaming
music player only vibrates until it senses dancing/movement then plays music.
more movement = louder
pulling 'hair'
broken telephone?
stroke the ego
intercom system
step on button
stroke the lamp it turns on.
(stepping on his toes)
not relative to project focus also not thinking of energy as material
glow foam?
skipping rope extension lead.
physical interaction.
energy monsters
what shapes would they use?
'twig' starts to stand on end when 1% generated!

user picking up the weight and placing it into the Monster's mouth is equal to 0.1% of the energy required by the appliance for a specific amount of time (table 4.2).

The form of the Monster was then explored paying close attention to how the user will be interacting with the product. Initial iterations (figure 4.3) looked at the varying ways the Monster could be realised, which at first were quite abstract but then become more simplified and stylised. The height off a surface was important to keep in mind as well as the space in which the weights would fall and accumulate. It was also crucial to consider the feedback and overall experience; how familiar is the object in the way it is fed and processes the 'food'.

The chosen form is inspired by a wall mounted switch, somewhat abstracted and stylised, the protruding shell or 'belly' moves in a manner like a switch. Similar to a wall-mounted switch or plug socket, the Energy Monster is partially mounted on the wall. It does, however, have rigid legs that ensure it remains at the required height as well as provides extra support for the object, especially when it is holding the weights.

In order to incorporate the idea of tangibly experiencing electricity, the plasma ball was included. This is not only visually interesting but also allows the user to touch it causing arcs to follow one's finger; a tangible experience.

how much energy to power... E (J) = Power (watts) x time (sec.)		Joules (J)	.1%
boil 1 cup of water (approx. 1 min)		85 772 - 92 160	85.8 - 92 J
power TV for	1 hour	108 000J	108J
	10 min.	18 000J	18J
	1 min.	1800J	1.8J
charge laptop for	1 hour	216 000J	216J
	10 min.	36 000J	36J
	1 min.	3600J	3.6J
toast 1 slice of bread (approx. 95s)		80 750J	80.75J
power LED lamp for	1 hour	50 400J	50.4J
	10 min.	8400J	8.4J
	1 min.	840J	0.84J
power wireless router for	1 hour	21 600J	21.6J
	10 min.	3600J	3.6J
	1 min.	360J	0.36J
fry 1 egg on electric stovetop (approx.6 mins)		540 000J	540J
power hairdryer for	1 min.	108 000J	108J

Table 4.2: Energy equations (Quail, 2015)

Additional components that were explored included the use of an OLED screen, LED indicators and a speaker. Some concerns included information overload and elements that distract from one another, ultimately causing a demise in the overall experience. A speaker was the remaining option, which could be used to indicate a number of things through sound. Additionally, use of a speaker separates it from an object that merely displays information for one to choose to view or not.

4.2.1 USER VALIDATION AND FINAL DESIGN

A user validation session was conducted in which the proposed design and interaction could be analysed and discussed. Those who had taken part in the cultural probe were invited as well as two other people who had less knowledge on the project. Users were encouraged to pick up the weights and interact with the Energy Monster prototype and plasma ball (figure 4.4). A number of issues were discussed including the overall experience, material choices and success of the idea.

Figure 4.4: Validation objects (image by author, 2015)

Beginning with the various components, the weights were found to be an appealing shape, size and weight. User B commented *"when I sat down I immediately wanted to play with them, I found them really appealing."* Many agreed that it was heavier than they expected it to be. Modelling the weights like doughnuts or cookies was unanimously agreed upon with enthusiasm. Additionally it was added that it also had symbolic value as the idea of the gluttonous Energy Monster wanting doughnuts reflecting an insatiable use of power hungry appliances. It was also noted by user D that there needs to be a relationship between the shape of the weight and where it is placed, the mouth opening.

The plasma ball was a well-received component and something all the users liked. Initially the plasma ball was to turn on after one weight had been dropped in. All the users, however, agreed that it would be more beneficial and novel if the plasma turned on once the monster had been fed enough weights, remaining on for the duration the appliance can be on. User C added that *"it's more of a novelty if it only lights up once you've put in enough effort"*.

The use of the speaker was discussed and the group did not find it necessary for it to give any time indications or values. User D initially questioned its validity as one is *"already making somebody aware by doing a physical activity"*. Stripping back all the components was preferred, so using the plasma ball as an indication of when the Monster is satisfied, as opposed to extra light indicators or screens. The repetitive "feed me" was recognised for its intent but most agreed that they would like to have an option to turn this off. The group noted that for children, it would be great, but for adults it would become tiresome and annoying.

Discussing the use of materials, most agreed that they liked the idea of using recycled materials or something more natural. Options were again noted with half the group preferring neutral, pastel colours

and the other half liking brighter colours or patterns. Perforated metal was another option, which at first was met with scepticism. Its intent however, so one can vaguely see the working components inside, changed the groups opinion. Everyone liked the idea that you could see what was happening inside as opposed to it being a mystery like most devices and appliances.

The overall look and shape was liked by the group. User B commented that *"it's a very appealing product"* and user D said that *"it's humorous but also simple... there's something weird and dark about it at the same time"*. Two options for how and where it would be placed in the kitchen were discussed. Some preferred the idea of a freestanding object but majority preferred to keep counter space clear, so would rather have it wall-mounted. It was, however, noted that this would have to be something that could be done with ease, such as using of suction pads that do not require nails to be inserted into the wall or tiles.

The concept as a whole was well received and the group saw the validity in it with user F saying *"it's almost like an energy monitor but putting it in terms of human effort"*. The group also noted its educational value for children as well as adults. User A commented that *"the biggest energy consumption is your behaviour, in the long run, although it uses extra electricity, it's educational"*.

With the results and comments from the user validation session the design could be finalised.

Figure 4.5: Proposed design illustration (image by author, 2015)

4.2.2 ERGONOMICS/HUMAN FACTORS STUDY

Ergonomics and human factors study is a field that focusses on the study of the usability, safety, comfort and efficiency of products and systems; the aim is to enhance the experience for the user. The design and form of a product can have a great impact on how pleasurable it is for the those using it, which in turn impacts on its success (Lin, 2003:1295)(Jordan, 1998:33).

Considering the role of ergonomics in this design is largely related to the interaction and feedback. Another important factor that was considered is affordance, how does one know to put a weight in the mouth of the Monster or where to plug in the appliance? The weight and shape of the mouth opening therefore correspond. Once the appliance has been plugged into the left hand side of the Monster, it begins repeating "feed me" causing the user to respond. All the electronic components impact on the usability of the product. The speaker stops and the plasma switches on once the monster is satisfied. The servo motor rotates the outer shell to drop the weights when the appliance has used the allocated energy.

Factors such as safety were also considered. Live electricity is incredibly dangerous, therefore representing it has been done in a way that will not harm the user, i.e. using the plasma ball. Additionally, the weights pose a risk of falling off tables or counters when released from the Monster. Therefore a tray accompanies the Monster which not only holds the weights but acts as a catchment space.

Overall the design has remained fairly simple, stripping back any unnecessary extras such as light indicators and screens. This is to diminish any confusion or overload of information for the user. Finally, anthropomorphic features are intentionally rudimentary; this includes the 'eyes', leg-like supports and extending wire 'arms'. These features have been designed in such a way to create a playful idea of a mechanical, power-hungry creature.

4.2.3 MATERIALS AND MANUFACTURING

The materials that have been chosen allow the user to vaguely see the inner workings of the monster. This is in an effort to demystify what happens within electronic devices. Due to the nature of the project, manufacturing processes have been chosen that are more suited to smaller, batch production.

4.2.3.1 BODY

For the main housing of the Monster, perforated aluminium sheet has been chosen. In addition to providing some transparency, it is a light material and reflective to heat (Ferguson Perforating, 2015). A standard round hole 60 degree triangular pattern sheet will be used as this is the strongest and most versatile (O'Donnell and Associates, 2015). The aluminium will be powder coated; an advantageous coating process due to the reduction in air pollution when compared to liquid coating processes (McClatchley, 2015).

Powder coating is a process in which the metal is first treated and then pigmented powder is applied. The powdered metal is then placed in an oven to bake. The result is a durable coating that is resistance to scratches and corrosion (Deanne, 2008).

Aluminium sections will be welded together by a process of resistance welding, a technique suited to joining sheet metal. High voltage between two electrodes and resulting heat cause the metal to fuse together. No additional materials such as flux or filler are required for this process and the quality of the weld is consistently high (Thompson, 2011:146).

The front shell or 'belly' will be made from polycarbonate. PC is suitably transparent and can be coloured in a number of hues. Another important property is its resistance to impact due to its high strength. It is also non-toxic and can easily be recycled (Buitrago, 2015).

Polycarbonate is a thermoplastic which makes it suitable for vacuum forming. Vacuum forming is a relatively inexpensive process in which sheet material can be formed into varying shapes. A single sided mould is used to form the shape. Placed in the machine, the plastic sheet is heated until it starts to soften, the mould is then pushed up and then a vacuum draws the sheet tightly over the mould (Thompson, 2011:23).

4.2.3.2 WEIGHTS:

Initially lead was considered for the production of the weights due to its density and relatively low melting point which would make it easy to manufacture. The material, however, is incredibly toxic and potentially hazardous to work with (Lyman, 2015). It was therefore decided to use mild steel as it is relatively dense, 7.60 g/cm3, yet does not pose as many health risks as lead. The approximate mass of each weight is 200g.

4.2.3.3 ELECTRONICS

In order to prototype the interactive components an Arduino uno was used. This programming device is open-source and allows for a number of applications to be realised. The basic interaction and flow of processes is shown in the flow chart (table 4.3). Elaborating on each component will justify its need for inclusion.

Servo motors are electric devices that are used to control the movement of parts in a machine. They are commonly used in toys such as radio-controlled cars and airplanes, as well as electronic household items like DVD players. A servo motor made up of a small DC motor and an arrangement of gears which slow down the high speed of the motor in turn increasing the torque; creating a big force over a small distance (Eglowstein, 2015). A servo motor is used to control the degree of rotational movement of the outer shell. The speed and position can be controlled accurately, making it suitable for use in the project. Additionally, their small size, high performance and programmable speed makes it a suitable component (Baldor Electric Company, 2015).

CT sensor or current sensors are used to record and monitor energy consumption. The device is used to detect the current which it then converts to an output voltage. There are two types of current sensors, direct and indirect (Jain, 2012). A 50A current sensor that measures both AC and DC current has been chosen for the Energy Monster as it is Arduino compatible and is small in size with extremely low power-loss (Allegro Microsystems, 2015:1). The sensor will calculate how much energy the appliance requires which will then be relayed to the Arduino in order to compute the other mechanisms accordingly.

Speaker simply repeats "feed me" when the appliance has been plugged into the Energy Monster. This continues until the Monster is satisfied and the accompanying appliance or product can start working. It then switches off until it requires more energy again.

Weight Sensor, load cell or more specifically a strain gauge is what one would typically find in an electronic bathroom scale. The device measures the applied force through electrical resistance changes

Table 4.3: Flow chart (Quail, 2015)

(Al-Mutlaq, 2015). A 10kg straight bar load cell will be used for the Energy Monster. This would be housed beneath the internal wall so it can measure the weights as they fall into the body.

The **plasma lamp** (fig. 4.5) was first invented by Nikola Tesla in the late 1800s. Designer William Parker popularised the idea through his design in the 1980s (University of Oxford Department of Physics, 2015). Essentially it consists of a glass globe, metal electrode and a number of components as seen in figure 4.6. At the centre of the globe a large alternating voltage is applied to the metal electrode. Low density gas within the globe, typically neon, allows for an electrical field to be created between the electrode and outer globe. An electromagnetic field is created by the alternating voltage which ensures the plasma is contained and continues to form (University of Oxford Department of Physics, 2015)(4Physics, 2012).

The plasma globe has been incorporated in order to portray the idea of tangible interaction with electricity. It appears to be the brain of the Monster as it switches on when a weight is dropped into the housing. The user can additionally touch the globe causing the arcs to form and follow one's hand.

Figure 4.6: Plasma ball (image by author, 2015)

Figure 4.7: Plasma ball components (image by author, 2015)

5.0 MARKETING AND BUSINESS

A business plan is an integral part of launching a new product, company or brand. Yet the research and direction taken for this project does not fall within the typical confines of a capitalist reality. In order to maintain the integrity and purpose of the energy monster, a suitable alternative plan will be outlined. These include suitable forms of promotion and sales which will be described in the marketing mix, and then elaborated upon in the media plan.

The main objective of the product is to provide an engaging experience that highlights the invisibility of energy use within the home. As guided by the theoretical framework, it does not necessarily fall under a consumer product but rather a speculative or critical object.

5.1 FIVE P's

The marketing mix is one way for a company to assess how they will enter the market, who they are targeting, where and at what price (Parker & Illentschko, 2006:175). Product, place, promotion and price are the four basis P's; people will be included making it 5 P's. As the product is geared towards users, the fifth P is a vital addition and component to be defined.

PEOPLE

People refers to the target audience, or to whom the product is geared. It is crucial that one understands the needs and preferences of their target audience. This can be done through a number of varying research methods. For the energy monster cultural probes, semi-structured interviews and user validation sessions were conducted (Tracy, 2004). The target audience for the Energy Monster is directly influenced by access to adequate electricity. Additionally they use a number of electricity-using products on a daily basis without much concern for what it is costing them. While this is fairly broad, it can be noted that they would earn an adequate income that affords them the ability to purchase

various home appliances and electronic devices as well as maintain household costs, i.e., electricity, utilities, rent.

PRODUCT

The product is what you are selling to meet the needs of the people or target audience, either tangible or intangible (Boundless, 2015). The Energy Monster is defined as a tangible product; an engaging, alternative device that questions our interaction and use of energy on a daily basis highlighting how reliant on electricity one can unknowingly become. It also reaches a broader topic of design as a tool for conversation, to alter ideas and initiate change. It is specifically used in conjunction with any household appliance and requires the user to feed weights into the body in order for the appliance to be used.

PLACE

Place refers to where the product will be sold, which could include retail stores, pop-up shops or online platforms. It is crucial that appropriate avenues are chosen in order to reach the target audience (Parker & Illentschko, 2006:177). Selective distribution would be suited to the energy monster should it be stocked in stores. It would unlikely be found in your local supermarket, rather sales would primarily be done through an online store.

PROMOTION

The basic aim of promotion is to provide information for the users, to increase demand and to clearly illustrate what makes the product different from competitors (Boundless, 2015). The main form of promotion will be through viral marketing, use of an interactive website, social media platforms

Table 4.3: Costing (Quail, 2015)

DESCRIPTION	SUPPLIER	COST(R)
Aluminium	Eurosteel	52
Perforated Aluminium	Eurosteel	120
Polycarbonate 3mm	Maizey's	113
Powder coating	Cape Powder Coating	35
Mild steel 35mm round bar	Zaya Metal Trading	91
Arduino uno SMD R3	Communica	279
9g Micro-servo motor	Communica	65
Load cell, 10kg straight bar	SparkFun	96
Plasma Ball	The Gadget Shop	250
Speaker	Zakspeed	15
Cable and wires	Communica	10
Plug	Builders Warehouse	12
	TOTAL	1138

Estimated costing for production of one monster*

*batch of twenty

and sponsored advertising. In addition the product can be sponsored to people, schools or companies across the world.

PRICE

Price refers to what a customer pays for a product or service. Price plays a vital role in establishing a certain image, this is of particular relevance to the project (Boundless, 2015). The Energy Monster will therefore be an open source, not for profit concept. The user therefore only pays the cost of making the product as well as any additional shipping fees. A barter-type system was also considered where users could exchange defective or unused electrical devices for a percentage of the cost of a monster. In this way becoming a part of a greater debate on the obsolete nature of many electronic products. However the parts needed for the monster are only found in a few devices so it was decided against.

5.2 SWOT ANALYSIS

Analysing the Energy Monster in a commercial framework may run the risk of over-looking its true potential. Therefore in keeping with the guiding principles, the design's strengths, weaknesses, opportunities and threats will be scrutinised within the idea of future finds or speculative devices. The marketing mix provides a clear picture of how, where and by whom this product may be received, the following analysis then reviews it within that context.

Strengths: Engaging, alternative, playful, informative, unconventional, conceptual

Weaknesses: Not a stand-alone product/accessory to appliance, feedback overload

Opportunities: Alternative, creates debate, talking point, educational tool

Threats: Industry, consumerism, narrow-mindedness, conventional thinkers

5.3 MEDIA PLAN

In order to create the desired image, a suitable name and media strategy have been developed. It was important to develop a name that humorously comments on the interactive components of the product. Nuusense is a play on words that reflects the idea of gaining a new sense or understanding about energy or electricity, as well as the fact that the product demands one's attention through the repetitive speaker, almost like a hungry pet. The senses (touch, sight, sound) also play a crucial role in the product which is implied in the name. The logo is suitably playful as it simply creates the idea of a smiling creature (figure x).

A website will be the primary mode of promotion due to the global reach of the internet. The website will incorporate interactive animation that simulates the engagement with Nuusense. Key information as well as estimates on power hungry appliances will be provided. All in a fun and playful manner by using images and little text. Visitors to the website can easily share it with friends and colleagues through Facebook, Twitter and Google Plus. These three social media platforms will be used primarily to remain engaged with users through updates and relevant facts. In addition, the use of Google Plus will help improve organic search rankings for the product and website in Google.

In order to maintain traffic to the website, the landing page will be themed seasonally; for example a focus on heating in winter months and air-conditioning in summer months. On entering the site a Northern or Southern hemisphere option will be provided which ensures the appropriate season is given. This will however not limit the information available to the visitor but rather is in an effort to remain relevant and international.

A sponsorship programme would be available where people or companies can sponsor a school, household or individual an energy monster. This will be in addition to the option to purchase one for one's own home. This would all be run through the website, and users would be encouraged to post comments and photos of Nuusense around the world.

A type of guerrilla marketing tactic would be investigated through sponsorship or permission from Eskom to print Nuusense on electricity slips. Instead of flyers, one would be utilising something that already needs to be printed. It would most likely take the form of a simple vector image with the caption "How power hungry is your household?" or "How balanced is your energy diet?" along with the website URL.

nuusense

Figure 5.1: Logo (Quail, 2015)

6.0 CONCLUSION AND RECOMMENDATIONS

In conclusion, the research began as an investigation into the way in which people experience electricity or energy-using products within the home. The aim being to design an item that explores energy as material and tangibly experienced.

Appropriate literature provided the basis from which primary research could be conducted. The chosen methodology, phenomenography, ensured a focus was placed on the way in which people experience phenomena. Critical design then provided a guiding framework from which the project could be developed; that of strangely familiar, intriguing objects that endeavour to initiate debate or question current practices.

Semi-structured interviews and cultural probes provided an insight into the way in which people experience electricity or energy-using products on a daily basis. The results were then used to formulate a number of requirements which guided the development of a suitably interactive design.

The resulting product, Nuusense, similarly to an energy monitor measures the amount of electricity required by your devices and appliances. However, unlike an energy monitor this energy monster requires your efforts in order for the adjoining device or appliance to be turned on. The unconventional engagement and inherent commentary on power hungry devices ultimately provides the user with an impressionable experience.

6.1 RECOMMENDATIONS FOR FURTHER IMPROVEMENT

In order for the design to remain relevant and challenging a few aspects could be further improved upon. The limited time frame only allowed for a certain amount of development for the electronics, this is an area which could be improvement by developing a more energy-efficient configuration. There is also a possibility for a more sophisticated weighing and sorting system which would allow for weights of varying sizes.

FEATURES & BENEFITS

PLASMA GLOBE:
to tell you when Nuusense is satisfied, as well as providing an interaction with electricity.

SUCTION CUP TAPE:
for extra support.

PERFORATED WALLS:
have a look-see what is happening inside.

TRANSPARENT BELLY:
all the better to see your efforts with.

PERSISTENT SPEAKER:
because Nuusense is hungry and you need to know.

THREE-POINT PLUG CONNECTION:
so Nuusense can be friends with more appliances.

STURDY LEGS of steel.

The body has intentionally remained muted in colour with a white powder coated perforated aluminium body and transparent polycarbonate 'belly' and 'back'. A flesh-like colour tongue sits in the mouth area. This is to indicate to the user that the weight should be placed there. The weights are very colourful and bright in an effort to attract the user to pick them up and begin the interaction. Nuusense is semi-independent, with two sturdy steel legs to support the mass of the weights. In addition, it is 'mounted' onto a wall with suction cup tape. This is to ensure Nuusense does not take up too much counter space.


Lelit


nuusense

BIBLIOGRAPHY

4Physics 2012. An Introduction to Plasmas. *4Physics*. [Online]. Available: http://www.4physics.com/phy_demo/plasma1.htm [26 October 2015].

Al-Mulaq, S. 2015. Getting Started with Load Cells. *Spark fun*. [Online]. Available: https://learn.sparkfun.com/tutorials/getting-started-with-load-cells?_ga=1.187053352.1056452009.1443018499 [2 November 2015].

Allegro Microsystems 2015. *Thermally Enhanced, Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 100 ohm Current Conductor*. Massachusetts (published pdf).

Arnall, T. 2014. Exploring 'Immaterials': Mediating Design's Invisible Materials. *International Journal of Design*. 8(2). 101-117.

Baldor Electric Company. 2015. Servo Control Facts: A handbook explaining the basics of motion. *Baldor*. [PDF]. Available: http://www.baldor.com/Shared/manuals/1205-394.pdf [26 October 2015]

Blauvelt, A. 2004. *Strangely Familiar: Design and Everyday Life*. Minneapolis: Walker Art Centre.

Buitrago, C. 2015. Polycarbonate (PC). *Courses*. [PDF]. Available: http://wwwcourses.sens.buffalo.edu/ce435/PC_CB.pdf [2 November 2015].

Boundless 2015. Product, Placement, Promotion, and Price. *Boundless Marketing*. [Online]. Available: https://www.boundless.com/marketing/textbooks/boundless-marketing-textbook/introduction-to-marketing-1/introduction-to-marketing-18/product-placement-promotion-and-price-108-4454/ [26 October 2015]

Csikszentmihalyi, M. 2009. *Flow: the psychology of optimal experience*. New York: Harper Collins.

Dalsgaard, P. 2008. Designing for Inquisitive Use. In: *Designing Interactive Systems. Proceedings of the 2008 ACM conference, Cape Town, 25-27 February 2008*. 21-30.

Deanne, R. 2008. Powder Coatings and Sustainability. *AkzoNobel*. [Online]. Available: https://www.akzonobel.com/powder/sustainability_in_powder/powder_coatings_and_sustainability/ [2 November 2015].

Desmet, P & Hekkert, P. 2007. Framework of Product Experience. *International Journal of Design*. 1(1):57-66.

Dortins, E. 2002. Reflections on phenomenographic analysis: Interview, transcription and analysis. *HERDSA conference*. 207-214.

Dunne, A. 1999. *Hertzian Tales: electronic products, aesthetic experience and critical design*. Cambridge, Massachusetts: MIT Press.

Dunne A. & Raby, F. 2001. *Design Noir. The Secret Life of Electronic Objects*. Switzerland: Birkhauser.

Dunne, A. & Raby, F. 2015. Critical Design FAQ. *Dunne and Raby*. [Online]. Available: http://www.dunneandraby.co.uk/content/bydandr/13/0 [8 May 2015]

Dunne, A. & Raby, F. 2013. *Speculative Everything: Design, Fiction and Social Dreaming*. Cambridge, Massachusetts : MIT Press.

ECAL 2014. *Delirious Home*. Milan. (published)

Eglowstein, H. 2015. Introduction to Servo Motors. *Science Buddies*. [Online]. Available: http://www.sciencebuddies.org/science-fair-projects/project_ideas/Robotics_ServoMotors.shtml [26 October 2015].

Ferguson Perforating 2015. Perforated Aluminium. *Ferguson Perforating*. [Online]. Available: http://www.fergusonperf.com/the-perforating-process/material-information/perforated-aluminum.asp [2 November 2015].

Frearson, A. 2015. Video reveals trial of smoke-ring-blowing chimney for BIG's Copenhagen Power Plant. *Dezeen*. [Online]. Available: http://www.dezeen.com/2015/02/25/video-trial-smoke-ring-chimney-big-amager-bakke-power-plant-copenhagen/ [21 July 2015].

Fry, T. 2009. *Design Futuring*. London: Bloomsbury Academic.

Gabrys, J. 2014. A cosmopolitics of energy: diverging materialities and hesitating practices. *Environment and Planning*. 46(|). 2095-2109.

Gaver, B. 2002. Designing for Homo Ludens, Still. *Goldsmiths University*. [PDF]. Available: http://www.gold.ac.uk/media/46gaver-ludens-still.pdf [10 August 2015].

Gaver, B., Dunne, T. & Pacenti, E. 1999. Design: Cultural Probes. *Interactions*. 6(1). Jan/Feb. 21-29.

Gaver, B., Bowers, J, Boucher, A., Gellerson, H., Pennington, S., Schmidt, A,, Steed, A., Villars, N. & Walker, B. 2004. The Drift Table: Designing for Ludic Engagement. In: *proceedings of the 2004 CHI conference, 24-29 April, Vienna, Austria*. 1-16.

Jain, P. 2012. Current Sensor. *Engineers Garage*. [Online]. Available: http://www.engineersgarage.com/articles/current-sensor [26 October 2015]

Jensen, M. D. & Stienstra, M. 2007. Making Sense: Interactive Sculptures as Tangible Design Material. In: *Designing Pleasurable Products and Interfaces. Proceedings of the 2007 ACM conference in Helsinki, 22-25 August 2007*. 255-269.
Jordan, P.W. 1998. Human Factors for Pleasure in Design. *Applied Ergonomics*. 29(1): 25-33.

Klemmer, S.R., Hartmann, B., Takayama, L. 2006. How Bodies Matter: Five Themes for Interaction Design. In: *Designing Interactive Systems. Proceedings of the 2006 ACM conference, Pennsylvania, 26-28 June 2006*. 140 -148.

Larsen, E., Bjerring Olsen, K., Emanonilov, V. 2015. Consumption of electricity and its effect on environment. *World Counts*. [Online]. Available: http://www.theworldcounts.com/counters/interesting_facts_on_energy/consumption_of_electricity [3 November 2015].

Larsson, J. & Holmström, I. 2007. Phenomenographic or phenomenological analysis: does it matter? Examples from a study on anaesthesiologists' work. *International Journal of Qualitative Studies on Health and Well-being*. 2:55-64.

Lim, Y., Stolterman, E., Jung, H., Donaldson, J. 2009. Interaction Gestalt and the design of aesthetic interactions. In: *DPPI '07 Proceedings of the 2007 conference on Designing pleasurable products and interfaces*. 239-254

Liu, Y. 2003. The aesthetic and the ethic dimensions of human factors and design. *Ergonomics*. 46(13/14): 1293-1305

Lyman, 2015. Bullet Making Guide. *Lyman*. [PDF]. Available: http://www.lymanproducts.com/lyman/bullet-casting/pdf/LyC_BC_BMG.pdf [26 October 2015]

Malpass, M. 2012. [*Contextualising Critical Design*]. Nottingham: Nottingham Trent University. (PhD Thesis)

Marton, F. 1981. Phenomenography - Describing Conceptions of the World Around Us. *Instructional Science*. 10: 177-200.

Marton, F. 1986. Phenomenography: A Research Approach to Investigating Different Understandings of Reality. *Journal of Thought*. Fall 21(3): 28-49.

Mazé, R. & Redström, J. 2007. Difficult Forms: Critical Practices of Design and Research. *International Societies of Design Research*. 1-18.

McClatchey, P. 2015. How to decide between anodising, painting, and powder coating. *SAF*. [Online]. Available:

https://www.saf.com/how-to-specify/how-to-decide-between-anodizing-painting-and-powder-coating/ [2 November 2015]

Murphy, T. 2012. Burning Desire for Efficiency. *Do The Math*. [Online]. Available: http://physics.ucsd.edu/do-the-math/2012/05/burning-desire-for-efficiency/ [20 October 2015].

Odom, W., Blevis, E., & Pierce, J. 2008. Energy Aware Dwelling: A Critical Survey of Interaction Design for Eco-Visualisations. In: *OZCHI, Proceedings of the 2008 conference, 8-12 December 2008, Cairns, Australia*. 1-8.

O'Donnell and Associates 2015. Strength of Perforated Metal. *Ferguson Perforating*. [PDF]. Available: http://www.fergusonperf.com/pdfs/tolerances-options_strength.pdf [2 November 2015].

Parker, E. & Illetschko, K. 2006. *Eric Parker's Roadmap to Business Success*. Johannesburg: Frontrunner Publishing.

Pearsall, J., McPherson, F. & Holden, R. (eds) 2014. Energy. *Oxford Dictionary of English*. Oxford: Oxford University Press.

Perec, G. 1997. Approaches to What? *in: Species and Other Pieces*. edited by: J. Sturrock. London: Penguin Books.

Pierce, J. 2009. Material Awareness: Promoting Reflection on Everyday Materiality. In: *Spotlight on Works in Progress. Proceedings of the 2009 CHI conference, 4-9 April, Boston, USA*. 4459-4464.

Pierce, J. & Paulos, E. 2010. Materializing Energy. ***Paper presented at DIS 2010***. August. 1-

Reed, B. 2006. Phenomenography as a way to research the understanding by students of technical concepts. In: Núcleo de Pesquisa emTecnologia da Arquitetura e Urbanismo (NUTAU): Technological Innovation and Sustainability. Sao Paulo, Brazil, 1-11.

Richardson, J.T.E. 1999. The Concepts and Methods of Phenomenographic Research. ***Review of Educational Research***. Spring vol 69 no. 1: 53-82.

Schiano, D.J., Pierce, J. & Paulos, E. Home, Habits, and Energy: Examining Domestic Interactions and Energy Consumption. In: *Proceedings of the 2010 ACM conference, 10-15 April, Atlanta*. 1-11.

Senda, S. 2015. marcus tremonto's foiLED again series of formable copper lights. *Design Boom*. [Online]. Available: http://www.designboom.com/design/marcus-tremonto-foiled-again-copper-lights-04-26-2015/ [16 August 2015].

Sengers, P., Boehner, K., David, S., & Kaye, J. J. 2005. Reflective Design. In: *AARHUS, proceedings of the 2005 ACM conference, 21-25 August, Aarhus.* 49-58.

Thackara, 2005. *In The Bubble: Designing in a complex world*. MIT Press: Cambridge.

Thompson, R. 2011. *The Manufacturing Guides: Prototyping and Low-Volume Production*. London: Thames and Hudson.

Tracy, B. 2004. The 7 Ps of Marketing. *Entrepreneur*. [Online]. Available: http://www.entrepreneur.com/article/70824 [26 October 2015].

University of Oxford Department of Physics 2015. Plasma Ball. *University of Oxford Department of Physics*. [Onine]. Available: http://www2.physics.ox.ac.uk/accelerate/resources/demonstrations/plasma-ball [26 October 2015]

Walker, S. 2011. *The Spirit of Design: objects, environment and meaning*. Earthscan: London.

Walker, B., Gaver, W, W., Boucher, A., & Pennington, S. 2004. Cultural Probes and the value of uncertainty. *Interactions*. Volume XI.5. 53-56.

Wallace, J., McCarthy, J., Wright, P.C., Olivier, P. 2013. Making Design Probes Work. In: *Changing Perspectives. Proceedings of the 2013 ACM CHI conference, Paris, 27 April- 2 May 2013*. 3441-3450.

Wilcox, D. 2014. *Variations on Normal*. London: Square Peg.

Wiles, T. 2015. Involuntary Pleasures. *Ted Wiles*. [Online]. Available: http://tedwiles.com/Involuntary-Pleasures [12 August 2015].

Yates, C. Partridge, H. & Bruce, C. 2012. Exploring information experiences through phenomenography. *Library and Information Research*. 36(112). 96-119.